Lectures in General Biology

محاضرات في علم الحياة العا م

جامعة الملك عبدالعزيز

المصطلحات العلمية

Glossary for chapter 1 (Exploring Life)

المصطلـــــــــــــــــــــح	تعريف المصطلــــــــح
Biology Is The Science Of Life In All Its Living Forms, Plants, Animals And Microorganisms Including Man	**علم الحياة** هو علم دراسة ظاهرة الحياة ممثلة في النبات والحيوان والكائنات الدقيقة وكذا الإنسان
Biology Is The Scientific Study Of Life	**علم الأحياء** هو الدراسة العلمية للحياة
The Term "**Biology**" Derived From *Bios* = Life And *Logos* = Science *Logos*	مصطلح "**Biology**" مشتق من كلمتين يونانيتين : *Bios*يعني حياة و *Logos* يعني علــم
Living Organisms	**الكائنات الحية**
Adaptation	**التكيف** وهي التهيؤ والاستعداد الفطري للكائن الحي للعيش تحت ظروف بيئته التي يوجد فيها
Evolution	**التطور** هو عملية التغير المفطور عليها الكائن التي يكيف بها حياته ويحورها
Organization	**التعضية** صفة أخرى هامة للكائنات الحية بها تحدد موضوعات الدراسة في علم الأحياء
Hierarchy Of Life	**التنظيم الهرمي للحياة**
Emergent Properties	صفات جديدة تعرف بالصفات الناشئة
Biosphere	**الغلاف الجوي** – كل البيئات (الأنظمة البيئية) الداعمة للحياة على الأرض

Ecosystem	النظام البيئي – كل الجماعات من الكائنات المختلفة التي تعيش في منطقة معينة
Community	الجماعة – كل الكائنات المختلفة (العشائر المختلفة) التي تعيش في نظام بيئي معين
Population	العشيرة – كل أفراد النوع الواحد يتزاوجون فيما بينهم فقط في منطقة معينة
Organ Systems	الأجهزة العضوية – لها وظائف محددة وتتألف من أعضاء
Organs	الأعضاء – تؤدي وظائف محددة للكائن
Tissues	الأنسجة – مكونة من مجموعة من الخلايا المتشابهة
Molecules	جزيئات – تجمع من الذرات
Organelles	عضيات – تراكيب غشائية ذات وظائف محددة
Cells	خلايا – كيانات حية تفترق بغشاء عن بيئتها
Living and Nonliving Components	المكونات الحية والغير الحية
Photosynthetic Organisms	الكائنات القادرة على البناء الضوئي
Producers Are Called And Provide Food	المُنتجات توفر الغذاء
Consumers	المُستهلكات: كائنات تتغذى على النباتات أو على حيوانات
The Nonliving Components	المكونات غير الحية عبارة عن مواد غذائية كيميائية ضرورية للحياة

Recycle Chemicals	إعادة تدوير الكيماويات
Necessary For Life	ضرورى للحياة
Move Energy Through The Ecosystem	تحريك الطاقة خلال النظام البيئي
Prokaryotic Cells	خلايا أولية النواة
Genetic Material Is Not Surrounded By A Nuclear Membrane	المادة الوراثية غير محاطة بغلاف نووي
Simple And Small	صغيرة وبسيطة
Bacteria Are Prokaryotic	البكتيريا أولية النواة
Eukaryotic Cells	خلايا حقيقية النواة
Possess Organelles Separated By Membranes	تمتلك عضيات محاطة بأغشية تفصلها عن السيتوبلازم
Plants, Animals, And Fungi Are Eukaryotic	النباتات والحيوانات والفطريات حقيقية النواة
Nucleus: Contains DNA Surrounded By Nuclear Membrane	نواة: تحتوي على دنا محاط بغلاف نووي
Membrane	غشاء
DNA Is The Genetic (Hereditary) Material Of All Cells	الدنا هو المادة الوراثية لكل الخلايا
A Gene Is A Discrete Unit Of DNA	الجين عبارة عن وحدة مميزة من الدنا

Order	النظام – التعضي المعقد للكائنات الحية
Regulation	التنظيم – المقدرة على المحافظة على بيئة داخلية متناسقة مع الحياة
Growth And Development	النمو والتطور الجنيني
Energy Processing	معالجة الطاقة – اكتساب الطاقة وتحويلها لصورة نافعة للكائن بممارسة الأيض
Response To The Environment	الاستجابة للبيئة – قدرة الاستجابة للمؤثرات البيئي
Reproduction	التكاثر – المقدرة على إكثار النوع
Evolutionary Adaptation	التكيف التطوري – اكتساب الصفات الأكثر تناسباً للكائن مع بيئته
Domains	عوالــم
The Three Domains (Groups) Of Life	هناك ثلاث عوالم (مجاميع) حيوية
Bacteria - Prokaryotic, And Most Are Unicellular And Microscopic	البكتيريا – أولية النواة ، وعادة ما تكون وحيدة الخلية و مجهرية
Archaea - Like Bacteria, Are Prokaryotic, And Most Are Unicellular And Microscopic	البدائيات – أولية النواة ، وعادة ما تكون وحيدة الخلية و مجهرية شأنها شأن البكتيريا
Eukarya - Are Eukaryotic And Contain A Nucleus And Organelles	حقيقيات النواة – خلايا حقيقية النواة أي لها نواة و عضيات

THE PROCESS OF SCIENCE	الطريقة العلمية
Discovery Science	العلم الاستقرائي – يستخدم مشاهدات وقياسات متنوعة لوصف العلم
Hypothesis- Based Science	العلم الافتراضي (الإستنتاجي – الإستدلالي) – يستخدم البيانات الذي يوفرها العلم الاستقرائي وذلك لوضع تفسيرات علمية (إنه العلم التجريبي)
A Hypothesis	الفرضية هي تفسير مقترح لمجموعة من المشاهدات وبمعنى آخر هي الإجابة التخمينية للأسئلة التي تثيرها المشاهدة
A Theory	النظرية هي إستنتاج علمي مبني على التجربة مؤيد بعدد كبير ومتزايد من الأدلة المدعومة بالتجارب

Chapt. 3: The Chemical Basis of Life الأسس الكيميائية للحياة	
تعريف المصطلـــح	المصطلـــــــــح
Matter	المادة عبارة عن أي شئ له كتلة (وزن) ويشغل حيزاً ما
Matter Is Composed Of Chemical Elements	تتكون المادة من عناصر كيميائية
Element	العنصر – (هو المادة التي لا يمكن إنحلالها لمواد أخرى)
Essential Elements	العناصر الضرورية (توجد دائماً وأبداً في أي كائن حي)
Variable Elements	العناصر المتفاوتة (عناصر تدخل في تركيب الكائن الحي ولكنها تختلف في وجودها من كائن إلى آخر)
Trace Elements	العناصر الأثرية (عناصر تدخل في تكوين الكائن الحي بنسب ضئيلة جداً وقد يوجد أحدها أو بعضها في كائنات معينة دون غيرها)
Compound	المركب (هو مادة تتألف من إثنين أو اكثر من العناصر المختلفة والتي ترتبط بنسب ثابتة)
Atom	الذرة هي أصغر وحدة في المادة تحتفظ بخصائص العنصر
Proton	البروتون (وحيد الشحنة الكهربية الموجبة)
Electron	الإليكترون (وحيد الشحنة الكهربية السالبة)
Neutron	النيوترون (متعادل كهربياً)
Isotopes	النظائر والتي لديها نفس عدد الإلكترونات والبروتونات إلا انها تختلف في عدد النيوترونات

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الأسس الكيميائية للحياة

تعريف المصطلــــح	المصطلـــــــــح
Hydrogen Bond	الرابطة الهيدروجينية
Cohesion	خاصية التماسك
Surface Tension	التوتر السطحي
Hydrogen Bonds Are Responsible For Surface Tension	الروابط الهيدروجينية هي المسؤلة عن التوتر السطحي
Chemicals Other Than Water Can Contribute H^+ To A Solution	تستطيع الكيماويات (غير الماء) أن تعطي أيون هيدروجين للمحلول
They Are Called Acids	تسمى هذه الكيماويات أحماضاً
An Example Is Hydrochloric Acid (Hcl)	مثال ذلك حامض الهيدروكلوريك
This Is The Acid In Your Stomach That Aids In Digestion	هذا هو الحامض الموجود في المعدة والذي يساعد على الهضم
An Acidic Solution Has A Higher Concentration Of H^+ Than OH^-	تركيز أيونات الهيدروجين (H^+) في المحلول الحمضي أعلى من تركيز أيونات الهيدروكسيد (OH^-)
A Ph Scale (Ph = Potential Of Hydrogen) Is Used To Describe Whether A Solution Is Acidic Or Basic	يستخدم مقياس الأس الهيدروجيني pH (الجهد الهيدروجيني) لوصف ما إذا كان المحلول حامضي أو قاعدي

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الأسس الكيميائية للحياة

تعريف المصطلـــح	المصطلــــــــح
One Isotope Of Carbon Has 8 Neutrons Instead Of 6 (Written ^{14}C)	عندما يحتوي النظير الكربوني على 8 نيوترونات بدلاً من 6 يكتب ^{14}C
An Ion Is An Atom Or Molecule With An Electrical Charge Resulting From Gain Or Loss Of Electrons	الأيون هو ذرة أو جزيئ له شحنة كهربائية تنشأ من إكتساب أو فقدان إليكترونات
When An Electron Is Lost, A Positive Charge Results; When One Is Gained, A Negative Charge Results	تنشأ شحنة موجبة عند فقد الإليكترون وعند إكتسابه تنشأ شحنة سالبة
Two Ions With Opposite Charges Attract Each Other	يجذب الأيونان اللذان لهما شحنتان متعاكستان أحدهما الآخر
When The Attraction Holds The Ions Together, It Is Called An Ionic Bond	عندما يجعل التجاذب الأيونات متماسكة ببعضها البعض فإنه يطلق على ذلك الرابطة الأيونية
A Covalent Bond Results When Atoms Share Outer-Shell Electrons	تنشأ الرابطة التساهمية عندما تشترك الذرات في اليكترونات المدار الخارجي
A Molecule Is Formed When Atoms Are Held Together By Covalent Bonds	يتكون الجزيئ حينما تتماسك الذرات ببعضها البعض بواسط روابط تساهمية
Biological Molecules	الجزيئات الحيوية
Inorganic	غير عضوية
Organic	عضوية

Chapt. 3: The Chemical Basis of Life الأسس الكيميائية للحياة	
تعريف المصطلـــح	المصطلـــــــــح
Sulfur And Nitrous Oxides React With Water In The Air To Form Acids	تتفاعل اكاسيد النيتروز والكبريت مع الماء في الهواء لتكون أحماض
These Fall To Earth As Acid Precipitation, Which Is Rain, Snow, Or Fog With A Ph Lower Than 5.6	تهبط هذه الأحماض إلى الأرض كترسبات حمضية من خلال الأمطار والثلوج والضباب بأس هيدروجيني أقل من 5.6
Greenhouse” Effect And Alters Ocean Chemistry	إضافة المزيد من ثاني أوكسيد الكربون إلى الغلاف الجوي يساهم في إنتاج تأثير "البيت الأخضر" (يعرف أيضاً بتأثير الدفيئة أو الصوبة الزجاجية) كما يغير من كيمياء المحيطات

Chapt. 3: The Molecules Of Cells الجزيئات الخلوية

تعريف المصطلـــح	المصطلـــــــــــح
Organic Compounds (Molecules)	مدخل للمركبات(الجزيئات) العضوية
Organic Compounds	تسمى الجزيئات التي أساسها ذرة الكربون بالمركبات العضوية
Hydrocarbons	يسمى كل من الميثان والمركبات المؤلفة من كربون و هيدروجين فقط بالهايدروكربونات
Carbon Skeleton	تسمسى سلسلة ذرات الكربون بالهيكل الكربوني
Carbon Skeletons Can Be Branched Or Unbranched	قد يتفرع الهيكل الكربوني أو لا يتفرع
Therefore, Different Compounds With The Same Molecular Formula Can Be Produced	لذلك يمكن إنتاج مركبات مختلفة بنفس الصيغة الجزيئية
These Structures Are Called Isomers	تعرف هذه التراكيب بالنظائر
Functional Group Affects A Biological Molecule's Function In A Characteristic Way	تؤثر المجموعة الوظيفية في وظيفة الجزيئ الحيوي بطريقة مميزة
Hydrophilic (Water-Loving)	المركبات المحتوية على مجاميع وظيفية تكون محبة للماء
This Means That They Are Soluble In Water, Which Is A Necessary Prerequisite For Their Roles In Water-Based Life	يعني هذا أنها تذوب في الماء وهذا متطلب ضروري للقيام بوظائفها الحيوية المعتمدة على الماء
Hydroxyl Group—Consists Of A Hydrogen Bonded To An Oxygen	مجموعة الهيدروكسيل – تتكون من هيدروجين مرتبط بأوكسجين

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الجزيئات الخلوية

تعريف المصطلـــح	المصطلـــــــح
Carbonyl Group—A Carbon Linked By A Double Bond To An Oxygen Atom	مجموعة الكربونيل – كربون متصل بذرة أوكسجين برابطة ثنائية
Carboxyl Group—Consists Of A Carbon Bonded To A Hydroxyl Group And Double-Bonded To An Oxygen	مجموعة كربوكسيل – تتألف من كربون مرتبط بمجموعة الهيدروكسيل كما وترتبط برابطة ثنائية بالأوكسجين
Amino Group—Composed Of A Nitrogen Bonded To Two Hydrogen Atoms And A Carbon Skeleton	مجموعة أمين – مكونة من نيتروجين مرتبط بذرتي هيدروجين و هيكل كربوني
Phosphate Group—Consists Of A Phosphorus Atom Bonded To Four Oxygen Atoms	مجموعة فوسفات – تتكون من ذرة فوسفور مرتبطة بأربعة ذرات أوكسجين
Biological Molecules	هناك أربعة أصناف من الجزيئات الحيوية
Carbohydrates	الكربوهيدرات
Proteins	البروتينات
Lipids	اللبيدات (الدهون)
Nucleic Acids	الأحماض النووية
Macromolecules Because Of Their Large Size	تسمى عادة بالجزيئات الكبيرة لحجمها الكبير
They Are Made From Identical Building Blocks Strung Together	تسمى أيضاً بالبوليميرات لأنها مكونة من وحدات بنائية متماثلة متماسكة بقوة

Chapt. 3: The Molecules Of Cells
الجزيئات الخلوية

تعريف المصطلـــح	المصطلـــــــح
The Building Blocks Are Called Monomers	تسمى وحدات البناء بالمونيميرات
Dehydration Reactions, Which Remove Water	ترتبط المونيميرات ببعضها لتكون بوليميرات بتفاعلات نزع الماء
Polymers Are Broken Apart By Hydrolysis, The Addition Of Water	تنحل البوليميرات بالتميؤ أو الحلمأة (بإضافة الماء)
All Biological Reactions Of This Sort Are Mediated By Enzymes, Which Speed Up Chemical Reactions In Cells	كل هذه العمليات الحيوية من هذا النوع تتوسط فيها الإنزيمات التي تسرع من التفاعلات الكيميائية في الخلايا
Dehydration Reaction	تفاعل نزع الماء
Hydrolysis	التميؤ أو الحلمأة
Monosaccharides, Such As Glucose And Fructose	السكريات الأحادية عبارة عن مونيميرات سكر مثل الجلوكوز والفركتوز
Disaccharide In A Dehydration Reaction	يمكن أن يرتبط سكران أحاديان (مونيمران) ببعضهما البعض ليكونا سكراً ثنائياً بتفاعل نزع الماء
An Example Is A Glucose Monomer Bonding To A Fructose Monomer To Form Sucrose, A Common Disaccharide	مثال ذلك هو إرتباط مونيمر الجلوكوز بمونيمر الفركتوز لتكوين السكروز (سكر ثنائي شائع)

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الجزيئات الخلوية

تعريف المصطلـــح	المصطلـــــــــح
Starch Is A Storage Polysaccharide Composed Of Glucose Monomers And Found In Plants	**النشا عبارة عن سكرمتعدد تخزيني ويتكون من مونيميرات جلوكوز ويوجد في النبات**
Glycogen Is A Storage Polysaccharide Composed Of Glucose, Which Is Hydrolyzed By Animals When Glucose Is Needed	**الجلايكوجين أو النشا الحيوانيعبارة عن سكرمتعدد تخزيني ويتكون من الجلوكوز ، وتحلل الحيوانات الجلايكوجين عند الحاجة إلى الجلوكوز**
Cellulose Is A Polymer Of Glucose That Forms Plant Cell Walls	**السيليلوز عبارة عن بوليمير جلوكوزي يكون جدر الخلايا في النباتات**
Chitin Is A Polysaccharide Used By Insects And Crustaceans To Build An Exoskeleton	**الكايتين عبارة عن سكر متعدد تستخدمه الحشرات والقشريات لبناء هياكلها الخارجية**
Lipids Are Water Insoluble (Hydrophobic, Or Water Fearing) Compounds That Are Important In Energy Storage	**الليبيدات هي مركبات لا تذوب في الماء (كارهة للماء) ، وهي هامة في تخزين الطاقة**
They Contain Twice As Much Energy As A Polysaccharide	**تحتوي على ضعف الطاقة الموجودة في السكاكر المتعددة**
Fats Are Lipids Made From Glycerol And Fatty Acids	**الدهون (السمن والزبدة والزيت) نوع من الليبيدات مكونة من جليسيرول وأحماض دهنية**
Unsaturated Fats Because They Have Fewer Than The Maximum Number Of Hydrogens	**تسمى هذه المركبات بالدهون غير المشبعة لأنها تحتوى على عدد أقل من العدد الكلي للهيدروجين**

Chapt. 3: The Molecules Of Cells
الجزيئات الخلوية

تعريف المصطلـــح	المصطلـــــــــح
Fats With The Maximum Number Of Hydrogens Are Called Saturated Fats	تسمى الدهون المحتوية على العدد الكلي للهيدروجين بالدهون المشبعة (لا يوجد بها روابط ثنائية بين ذرات الكربون)
Phospholipids Are Structurally Similar To Fats And Are An Important Component Of All Cells	تشابه اللبيدات الفسفورية الدهون في تركيبها وهي من المكونات الأساسية للخلية
For Example, They Are A Major Part Of Cell Membranes, In Which They Cluster Into A Bilayer Of Phospholipids	على سبيل المثال هي مكون هام للأغشية الخلوية حيث تتجمع على هيئة طبقتين من الدهون الفسفورية
Steroids Are Lipids Composed Of Fused Ring Structures	الأسترويدات عبارة عن دهون مكونة من حلقات تركيبية متداخلة
Cholesterol Is An Example Of A Steroid That Plays A Significant Role In The Structure Of The Cell Membrane	الكوليسترول هو مثال للاسترويدات التي تلعب دوراً هاماً في تركيب غشاء الخلية
In Addition, Cholesterol Is The Compound From Which We Synthesize Sex Hormones	بالإضافة لذلك فإن الكوليسترول هو المركب الذي نبني به هرموناتنا الجنسية
Anabolic Steroids Are Synthetic Variants Of Testosterone That Can Cause A Buildup Of Muscle And Bone Mass	ستيرويدات الأيض البنائي عبارة عن توليفة صناعية من التيستيسترونات (هرمونات الذكورة) والتي تؤدي لبناء الكتلة العضلية والعظمية
Protein Is A Polymer Built From Various Combinations Of 20 Amino Acid Monomers	البروتين عبارة عن بوليمر يبنى من توافيق بين 20 من مونيمرات الأحماض الأمينية

Glossary for chapter 4 (cell and tissues)

المصطلح	تعريف المصطلح
Cells: the simplest collection of matter that can live.	**الخلايا** :هي أبسط تجمع من المادة يمكنه العيش.
Cell theory: all living things are composed of cells and that all cells come from other cells.	**نظرية الخلية :**أن كل الكائنات الحية تتكون من خلايا ، وأن كل الخلايا تأتي من خلايا أخرى.
Light microscope (LM): Light passes through a specimen then through glass lenses into the viewer's eye.	**المجهر الضوئي** :يمر الضوء خلال العينة ومن ثم إلى العدسات الزجاجية ومنها إلى عين المشاهد .
Resolution: the ability to distinguish between small structures.	قوة الإظهار: القدرة على التمييز بين التراكيب الصغيرة.
Electron microscope (EM): a very powerful microscope used to see very small structures.	**المجهر الإلكتروني** :يستخدم لتوضيح التراكيب الدقيقة جداً
Prokaryotic cells: cells that have no true organelles and no nucleus.	**خلايا أولية النواة**: خلايا لا تحتوي على عضيات حقيقية أو معقدة, ولا تحتوي على نواة حقيقية.
Eukaryotic cells :cells that have true organelles and true nucleus.	**خلايا حقيقية النواة**: خلايا تحتوي على عضيات حقيقية و تحتوي أيضاً على نواة حقيقية.
Selective permeability: controlling the movement of molecules into and out of the cell	**النفاذية الاصطفائية:** التحكم في حركة الجزيئات من و إلى الخلية.

المصطلح	تعريف المصطلح
Phospholipid bilayer: a double layer of phosphorated lipids (fats).	**الليبيدات الفسفورية:** هي طبقة مزدوجة من الليبيدات (الدهون) المفسفرة.
Nuclear envelope: double membrane with pores that allow material to flow in and out of the nucleus.	**الغلاف النووي:** عبارة عن غشاء مزدوج يحتوي على ثقوب تسمح بمرور المواد من وإلى النواة .
Endoplasmic reticulum: to a network of cellular membranes.	**الشبكة الإندوبلازمية:** شبكة من الأغشية الخلوية.
Ribosomes: are involved in the cell's protein synthesis.	**الرايبوزومات:** مسئولة عن بناء البروتين في الخلية.
Vesicles	**الحويصلات**
Golgi apparatus: functions in conjunction with the ER by modifying products of the ER.	**جهاز جولجي:** يعمل بالاشتراك مع الشبكة الاندوبلازمية على تهيئة منتجات الشبكة الاندوبلازمية.
Lysosome: a membranous sac containing digestive enzymes.	**الجسم** الهاضم: عبارة عن كيس غشائي يحتوي إنزيمات هاضمة.
Vacuoles: membranous sacs that are found in a variety of cells and possess an assortment of functions.	**الفجوات:** عبارة عن أكياس غشائية وتوجد في أنواع مختلفة من الخلايا ولها وظائف متنوعة.

المصطلح	تعريف المصطلح
Mitochondria: the organelle responsible for cellular respiration.	**ميتوكوندريا:** العضي المسئول عن التنفس الخلوي.
Chloroplasts: the photosynthesizing organelles of plants.	**البلاستيدات الخضراء:** هي عضيات البناء الضوئي في النبات.
Photosynthesis: the conversion of light energy to chemical energy of sugar molecules.	**البناء الضوئي:** هو تحويل الطاقة الضوئية إلى طاقة كيميائية في جزيئات السكر.
Cytoskeleton: a network of protein fibers, that functions in cell structural support and motility.	**الهيكل الخلوي:** شبكة من الألياف البروتينية والذي له وظائف مثل دعم التراكيب الخلوية والحركة الخلوية.
Microfilaments :(actin filaments) support the cell's shape and are involved in motility.	**الخيوط الدقيقة:** (خيوط الأكتين) وتعمل على تحديد شكل الخلية ودعمه ولها دور في حركة الخلية.
Intermediate filaments: reinforce cell shape and anchor organelles.	**الخيوط المتوسطة:** تعزز وتدعم شكل الخلية كما وتثبت العضيات .
Microtubules: (made of tubulin) shape the cell and act as tracks for motor protein .	**الأنيبيبات الدقيقة** (مصنوعة من التوبيولين) تشكل وتعمل كخطوط سير للبروتينات الحركية .
Extracellular matrix (ECM): composed of strong fibers of collagen, which holds cells together and protects the plasma membrane.	**المواد الخارج خلوية:** تتكون من الياف كولاجين قوية تعمل على تماسك الخلايا مع بعضها البعض كما وتقوم بحماية الغشاء البلازمي.

المصطلح	تعريف المصطلح
Integrins: ECM attaches through connecting proteins that bind to membrane proteins.	**الانتيجرينات** :تلتصق المواد الخارج خلوية بالخلية عن طريق البروتينات الرابطة والتي ترتبط ببروتينات الغشاء الخلوي المسماة.
Tight junctions: prevent leakage of extracellular fluid across a layer of epithelial cells.	**الإتصالات المحكمة**: تمنع تسرب السائل الخلوي الخارجي عبر طبقة الخلايا الطلائية .
Anchoring junctions: fasten cells together into sheet.	**الاتصالات المثبتة**: تشد الخلايا ببعضها البعض على هيئة صفيحة .
Gap junctions: are channels that allow molecules to flow between cells.	**الاتصالات الثغرية**: عبارة عن قنوات تسمح بتدفق ومرور الجزيئات بين الخلايا .
Cell wall: rigid structures that protect and provide skeletal support that helps keep the plant upright against gravity.	**جدر خلوية** : أغشية صلية تحمي الجدر الخلوية النبات وتدعمه هيكلياً ليبقى منتصباً إلى أعلى ضد الجاذبية .
Plasmodesmata: cytoplasmic threads that serve in communication between cells.	**البلازموديزماتا**: خيوط سيتوبلازمية تعمل على الاتصال بين الخلايا.

Glossary for chapter 5 (tissues)

المصطلح	تعريف المصطلح
Skeletal muscle: causes voluntary movements.	العضلة الهيكلية :تتسبب في الحركة الإرادية.
Cardiac muscle: pumps blood.	العضلة القلبية: تقوم بضخ الدم.
Smooth muscle: moves walls of internal organs, such as the intestines.	العضلة الملساء: تحرك جدر الأعضاء الداخلية مثل الأمعاء.
Neurons: carry signals by conducting electrical impulses.	الخلايا العصبية: تحمل الإشارات بتوصيل الدفعات الكهربية.
Dermal tissue :Outer protective covering.	النسيج الجلدي: غطاء خارجي واقي.
Vascular tissue: Support and long-distance transport.	النسيج الوعائي: الدعم والنقل لمسافات طويلة.
Ground tissue: Bulk of the plant body that functions as food production, storage, support.	النسيج الأساسي: تشكل معظم جسم النبات, و تقوم بوظيفة انتاج الطعام والتخزين والدعم .
Epidermis: Layer of tightly packed cells.	البشرة: طبقة من الخلايا المرتصة بإحكام.
Cuticle: Waxy layer on top of epidermis reduces water loss.	الأدمة:طبقة شمعية فوق البشرة تقلل من فقدان الماء.
Eudicot stem	ساق ذوات الفلقتين

المصطلح	تعريف المصطلح
Mesophyll :Leaf ground tissue.	**الميزوفيل (النسيج الوسطي): النسيج الأساسي في الورقة.**
Middle lamella: A sticky layer lies between adjacent plant cells.	**الصفيحة الوسطى: طبقة لزجة تقع بين الخلايا النباتية المجاورة.**
Lignin :the main component of wood.	**الليجنين: مكون أساسي للخشب.**
Fibers: long and thin, arranged in bundles.	**الألياف: طويلة ورقيقة وتنتظم في حزم .**
Sclereids: shorter than fibers, present in nut shells and pear tissue.	**الخلايا الحجرية: أقصر من الألياف وتوجد في قشور الجوز وأنسجة الكمثرى.**
Xylem :Chains of tracheids and vessel elements form tubes that make up the vascular tissue.	**الخشب: تشكل سلاسل القصيبات والعناصرالوعائية أنابيباً مكونة للنسيج الوعائي.**
Phloem: Chains of sieve tube members, separated by porous sieve plates, form the vascular tissue.	**اللحاء :سلسلة من الأنابيب الغربالية يفصل بعضها عن بعض صفائح مثقبة غربالية مكونة النسيج الوعائي.**
Meristematic cells: small, thin-walled, frequently cubical, densely packed with protoplasm, and capable of producing new cells by cell-division.	**الخلايا المريستيمية :خلايا صغيرة ، رقيقة الجدر ، وغالبا ما تكون مكعبة ، و ممتلئة بالبروتوبلازم ، و لها القدرة على إنتاج خلايا جديدة عن طريق الإنقسام الخلوى.**

المصطلح	تعريف المصطلح
Diffusion: is a process in which particles spread out evenly in an available space	الانتشار هو عملية شيوع الجزيئات بالتساوي في فراغ متاح
Selectively permeability: allow some substances to cross or be transported more easily than others	خاصية النفاذ التفاضلية وذلك بسماحها بسهولة مرور ونقل بعض المواد فضلاً عن غيرها
Concentration gradient: from high concentration to low concentration	مدرج التركيز من مناطق التركيز العالي إلى مناطق التركيز المنخفض
Passive transport: is the Diffusion across a cell membrane without energy	الانتقال السلبي هو الإنتشار خلال غشاء الخلية بدون الحاجة إلى طاقة
Active transport: a mechanism for moving a solute against its concentration gradient it requires the expenditure of energy in the form of ATP.	النقل النشط آلية لتحريك المذاب عكس اتجاه مدرج التركيز يحتاج ذلك لبذل الطاقة على هيئة الـ ATP.
Osmosis: the Water movement across membranes in response to solute concentration inside and outside of the cell down the concentration gradient.	الأسموزية هي تحرك الماء عبر الأغشية استجابة لتركيز المذاب داخل وخارج الخلية تجاه اسفل مدرج التركيز
Tonicity: is a term that describes the ability of a solution to cause a cell to gain or lose water	التوتر مصطلح يصف مقدرة المحلول على إكساب أو فقد الخلية للماء

المصطلح	تعريف المصطلح
Osmoregulation: is the ability of organisms to maintain water balance within their cells	التنظيم الأسموزي هي خاصية لدى بعض الحيوانات الحفاظ على إتزانها المائي داخل خلاياها
Facilitated diffusion: a type of passive transport that does not require energy	الانتشار المُدَعم نوع من النقل السلبي الذي لا يحتاج طاقة
Exocytosis: is used to export bulky molecules out of the cell	الطرد الخلوي آلية لتصدير الجزيئات الضخمة خارج الخلية
Endocytosis: is used to import substances useful to the livelihood of the cell	الابتلاع الخلوي آلية لتوريد مواد نافعة لمعيشة الخلية إلى داخل الخلية
Phagocytosis: engulfment of a particle by wrapping cell membrane around it, forming a vacuole	البلعمة أو الإلتهام الخلوي هو ابتلاع الجزيئات بتغليفها بغشاء الخلية مكونة فجوة
Pinocytosis: the same as phagocytosis except that fluids are taken into small vesicles	الشرب الخلوي عبارة عن نفس البلعمة إلا أن السوائل هي التي تؤخذ في حويصلات صغيرة
Cells: small units, a chemical factory, housing thousands of chemical reactions	الخلايا وحدات صغيرة هي بمثابة مصانع كيميائية تحتضن آلاف التفاعلات الكيميائية
Energy: is the capacity to do work and cause change	الطاقة هي القدرة على عمل شغل لإحداث تغيير

المصطلح	تعريف المصطلح
Metabolic pathway: is a series of chemical reactions that either break down a complex molecule or build up a complex molecule	**المسار الأيضي** عبارة عن سلسلة من التفاعلات الكيميائية والتي إما تهدم أو تبني جزيء معقد
Energy coupling: it is the use of exergonic processes (**energy releaser**) to drive an endergonic one (**energy receiver**)	**إقران الطاقة** استخدام التفاعلات المحررة للطاقة لإمداد التفاعلات المستقبله للطاقة بما تحتاجه من الطاقة
ATP(adenosine triphosphate): the energy currency of cells and it is the immediate source of energy that powers most forms of cellular work	**ثلاثي فوسفات الأدينوسين (ATP)** هو "عُملة" الطاقة في الخلية و **ATP** هو مصدر الطاقة الفوري الذي يزود معظم أشكال الشغل الخلوي بالطاقة
Active site: where the enzyme interacts with the enzyme's substrate	**منطقة نشطة** حيث يتفاعل الإنزيم مع عامل الإنزيم الخاص به
Cofactors: **inorganic** enzymes helpers	**العوامل المرافقة** هي مواد غير عضوية مساعدة للإنزيمات
Coenzymes: **organic** enzymes helpers	**مرافقات الإنزيمات** هي جزيئات عضوية مساعدة للإنزيمات
Competitive inhibitors: inhibits enzymes because they **compete** for the enzyme's active site and thus block substrates from entering the active site	**المثبطات التنافسية** تقوم بالتثبيط لأنها تستبق نحو الموقع النشط في الإنزيم وبالتالي تحجب عامله من دخول ذلك الموقع

المصطلح	تعريف المصطلح
Non competitive inhibitors: bind somewhere else and change the shape of the enzyme so that the substrate will no longer fit the active site	**المثبطات غير التنافسية** ترتبط هذه المثبطات بمكان آخر من الانزيم مغيره شكله فلا يصبح الموقع النشط مناسباً لعامل الانزيم
Feedback inhibition: a mechanism where the product of a metabolic pathway can serve as an inhibitor of one enzyme in the pathway	**بالتثبيط الرجعي الآلية** حيث يعمل أحد نواتج مسار آيضي كمثبط لأحد الإنزيمات في ذلك المسار
Cellular respiration: an exergonic process that transfers energy from the bonds in glucose to ATP	**التنفس الخلوي** هو عملية تفاعل محرر للطاقة والتي تحرر الطاقة المختزنة في روابط جزيء الجلوكوز وتخزينها في ATP
Kilocalorie (kcal): the quantity of heat required to raise the temperature of 1 kilogram (kg) of water by 1°C	**السعرة الحرارية (كيلو كالوري)** هي كمية الحرارة المطلوبة لرفع درجة حرارة 1 كيلوجرام من الماء درجة مئوية واحدة (ا ° م)
Dehydrogenase: the enzyme that removes hydrogen from an organic molecule	**الديهايدروجينيز (انزيم نزع الهيدروجين)** الإنزيم الذي يزيل الهيدروجين من الجزيء العضوي
NAD^+(nicotinamide adenine dinucleotide): a shuttle for electrons	**NAD+ (نيوكليتيدة الأدنين نيكوتين أميد الثنائية)**: ناقل للالكترونات
Glycolysis	**تحلل الجلوكوز**
The citric acid cycle	**دورة حامض الستريك**
Oxidative phosphorylation an enzymatic process in cell metabolism that synthesizes ATP from ADP	**الفسفرة المؤكسِدة** عملية إنزيمية أثناء أيض الخلية التى تصنع جزئ ATP من جزئ ADP

المصطلح	تعريف المصطلح
Fermentation: an anaerobic (without oxygen) energy-generating process	التخمر هو عملية توليد الطاقة لا هوائيا (دون الحاجة لأوكسجين)
Lactic acid fermentation: oxidizing of NADH by muscle cells and bacteria	تخمر الحامض اللبني تؤكسد الخلايا العضلية وبعض أنواع البكتيريا مركب الـ NADH
Yeasts: single-celled fungi that not only can use respiration for energy but can ferment under anaerobic conditions	الخمائر هي فطريات وحيدة الخلية ، الى جانب انها تستطيع القيام بالتنفس الخلوي (هوائيا) لإنتاج الطاقة فهي قادرة على القيام بعملية التخمر تحت الظروف اللاهوائية
Autotrophs: living things that are able to make their own food without using organic molecules derived from any other living thing	الكائنات ذاتية التغذية هي كائنات حية قادرة على تصنيع غذائها دون استخدام جزيئات عضوية مستمدة من أي كائن حي آخر
Photoautotrophs: the use of energy of light to produce organic molecules by Autotrophs	التغذية الضوئية استخدم طاقة الضوء لإنتاج جزيئات عضوية بالكائنات ذاتية
Chloroplasts: organelles consisting of photosynthetic pigments, enzymes, and other molecules grouped together in membranes	البلاستيدات الخضراء هي عضيات تتكون من صبغات مكونة للضوء وإنزيمات ومركبات أخرى مجموعة مع بعضها البعض في أغشية
Chlorophyll: an important light absorbing pigment in chloroplasts, is responsible for the green color of plants	الكلوروفيل صبغة هامة لامتصاص الضوء في البلاستيدات الخضراء وهي المسئولة عن اللون الاخضر في النبات

Biodiversity

المصطلـح	تعريف المصطلح
Domain	عالم: فئة تصنيفية فوق مستوى المملكة ويوجد ثلاث عوالم على مستوى الكائنات الحية: البدائيات والبكتيريا وحقيقيات النواة.
Kingdom	مملكة: الفئة التصنيفية الأكثر أتساعاً بعد العالم.
Phylum *Pl.* Phyla	شعبة والجمع شعب: فئة تصنيفية مقسمة لطوائف.
Class	طائفة: تجميع تصنيفي للرتب المتشابهة المتقاربة، وهي فئة فوق الرتبة وتحت الشعبة.
Order	رتبة: تجميع تصنيفي للفصائل المتشابهة المتقاربة وهو يعقب الطائفة ويعلو الفصيلة.
Family	عائلة: تجميع تصنيفي للأجناس المتقاربة المتشابهة وهي فئة تقع تحت الرتبة وفوق الجنس.
Genus *Pl.* Genera	جنس (الجمع أجناس) فئة تصنيفية فوق مستوى النوع يستدل عليها ويرمز لها بأول حرف من النوع كما هو متبع في نظام التسمية الثنائي.

المصطلـح	تعريف المصطلح
Species *Pl.* Species	نوع والجمع أنواع: نوع معين من الكائنات الحية يمتلك أفراده صفات تشريحية متشابهة ولهم القابلية للتكاثر (للتزاوج) فيما بينهم لا مع افراد غيرهم من الأنواع.
Evolution	تطور: كل التغيرات التي حولت الحياة على كوكب الأرض منذ بداياتها المبكرة وحتى التنوع الذي يميزها في عصرنا الحالي.
Evolutionary Species Concept	مبدأ تطور الأنواع فكرة أن كل الأنساب التطورية والأدوار البيئية يمكن أن تشكل قواعد تعريف الأنواع.
Bacteria	عالم البكتيريا (الجراثيم) أحد عالمي الكائنات أولية النواة، العالم الآخر هو البدائيات.
Bacterium *Pl.* Bacteria	بكتيرية (جرثوم - جرثومة) الجمع بكتيريا (جراثيم) كائن أولي النواة يتبع عالم البكتيريا.
Archaea	بدائيات أحد عالمي أوليات النواة حيث تمثل البكتيريا العالم الآخر.
Endospore	جرثومة داخلية خلية مقاومة ذات جدار سميك تنتج عندما تتعرض الخلية البكتيرية لظروف قاسية.
Prokaryotic Cell	خلية أولية النواة نوع من الخلايا يفتقر لوجود نواة مغلفة بغشاء (المادة الوراثية لايحيط بها غشاء)، كما لا يوجد بها عضيات مغلفة بأغشية وتوجد فقط في عالمي البكتريا والآركيا.

المصطلح	تعريف المصطلح
Eukaryote	حقيقي النواة كائن حي تحتوي خلاياه على عضيات مغلفة بأغشية ودنا مغلفاً بنواة الخلية ومرتبطاً ببروتينات.
Opportunistic Species	نوع انتهازي نوع يتميز بمعدل تكاثر عالي وتكوين جنيني سريع وتوالد مبكر وأجسام صغيرة الحجم وعمر بالغ غير محدد.
Anaerobic	لاهوائي الافتقار للأوكسيجين، ويعود لكائن حي أو بيئة أو عملية خلوية لا تستخدم الأوكسجين الذي قد يكون ساماً لها.
Aerobic	هوائي يحتوي أوكسجين، ويعود الاصطلاح على أي كائن حي أو بيئة أو عملية خلوية تحتاج للأوكسجين.
Chlorophyll	يخضور (كلوروفيل) صبغة خضراء موجودة داخل البلاستيدات الخضراء في النباتات، يشارك اليخضور مباشرة في تفاعلات الضوء مما يؤدي لتحويل الطاقة الشمسية إلى طاقة كيميائية.
Photosynthesis	بناء ضوئي عملية تحويل الطاقة الضوئية إلى طاقة كيميائية تختزن في الجلوكوز أو مركبات عضوية أخرى وتحدث في النبات والطحالب وبعض أوليات النواة.

المصطلـح	تعريف المصطلح
Binary Fission	**إنقسام (إنشطار) ثنائي** نوع من الإنقسامات الخلوية والذي تتكاثر به غالبية الكائنات وحيدة الخلية مثل أوليات النواة والأوليات حقيقية النواة، ويصبح بكل خلية بنوية منقسمة نسخة واحدة من الكروموزوم الأبوي.
Symbiosis	**معايشة** علاقة بيئية بين كائنين حيين لنوعين مختلفين يعيشان مع بعضهما البعض بإتصال مباشر.
Bioremediation	**معالجة حيوية** تحليل وتكسير الملوثات بواسطة كائنات حية
Protist	**كائن أولي** كائن حقيقي النواة وهو ليس نباتاً، أو حيواناً، أو فطراً
Alga *Pl.* Algae	**طحلب** – الجمع طحالب بدائيات شبيهة بالنباتات تقوم بعملية البناء الضوئي
Multicellular	**كائن متعدد الخلايا**
Parasite	**طفيل** كائن يمتص المغذيات من سوائل أجسام عوائل حية.
Predator	**مفترس** كائن حي يتغذى على كائنات حية أخرى.

المصطلح	تعريف المصطلح
Phytoplankton	**عوالق نباتية:** كائنات مجهرية ممثلة للضوء تسبح حرة في الماء.
Vascular Plants	**نباتات وعائية** نباتات ذات أنسجة وعائية، وتتكون من كل الأنواع الحديثة فيما عدا الحزازيات وأقاربها.
Rhizoid	**شبيه الجذر (جذير)** بنية مثبتة شبيهة بالجذر في الفطريات والنباتات اللاوعائية.
Seed	**بذرة** كيان في النباتات البرية مؤلف من جنين محمَّل مع غذاء مخزن داخل غلاف منيع.
Gymnosperm	**عارية البذور** نبات وعائي بذوره عارية غير مغلفة بأي محافظ متخصصة.
Angiosperm	**كاسيات البذور** نباتات زهرية تنتج بذوراً داخل غرفة محمية تعرف بالمبيض.
Mycelium	**غزل فطري:** الشبكة المتفرعة الكثيفة من الخيوط الفطرية في الفطر.
Filament	**خيط:** (1) سلسلة من الخلايا. (2) حامل الطلع في الزهرة.
Mycorrhizae	**جذر فطري (ميكورايزا)** مشاركة تكافلية (ترادفية) بين جذر نباتي وفطر.
Hypha	**خيط فطري** خيط يصنع كل جسم الفطر.

المصطلـح	تعريف المصطلح
Chytrid	كتريدة فطر له طور سوطي وهو رابطة تطورية محتملة بين الفطريات والأوليات.
Invertebrate	لافقاري حيوان لا يمتلك عموداً فقارياً، وتشكل اللافقاريات 95% من مجمل الأنواع الحيوانية.
Vertebrate	فقاري كائن حبلي له عمود فقاري ويمثله الثدييات والطيور والزواحف والبرمائيات والطوائف المختلفة من الأسماك.
Bud	برعم (1) فرع جنيني نباتي يشمل الأوراق الأولية (بصورة متقزمة ومتداخلة) وغالباً ما يحميه ويغطيه قشور برعمية خاصة (2) تكاثر لاجنسي في الحيوانات حيث يتطور نم خارجي إلى فرد جديد (3) تكاثر لاجنسي في الخمائر يتطور فيه بروز من الخلية الفطرية إلى خلية بنوية قد تنفصل من الخلية الأبوية أو تبقى ملتصقة بها.
Buding	تبرعم وسيلة غير جنسية للتكاثر حيث يتشكل نمو خارجي من الأب لينفصل مستقلاً أو يبقى ملتصقاً به لتتشكل في النهاية مستعمرات ذات امتداد واسع.
Asexual Reproduction	تكاثر لا جنسي نوع من التكاثر يشمل أباً واحداً يُنتج ذرية متشابهة وراثياً عن طريق التبرعم أو الانقسام لخلية واحدة أو كائن كامل إلى جزئين آخرين.

المصطلح	تعريف المصطلح
Sexual Reproduction	**تكاثر (تناسل / توالد) جنسي** نوع من التكاثر يعطي فيه الأبوين ذرية بها توليفة فريدة من الجينات الموروثة من أمشاج (جاميطات) كلا الأبوين.
Exoskeleton	**هيكل خارجي** غلاف صلب على سطح الحيوان كأصداف الرخويات وأدمة مفصليات الأرجل يؤمن الحماية ونقاط إتصال العضلات.
Arthropod	**مفصلي الأرجل** حيوانات لافقارية تمتلك هيكلاً خارجياً وارجل واجسام مفصلية (الجسم واجزائه مكونين من عقل)
Insect	**حشرة** طائفة من مفصليات الارجل ، أحسامها مقسمة إلى ثلاث أجزاء: الرأس والصدر والبطن ، وهي اللافقاريات الوحيدة التي تمتلك أجنحة وبعضها قادر على الطيران.
Arachnids	**العنكبيات** طائفة من مفصليات الأرجل تشمل العناكب والعقارب والقراد والحلم.
Mammalia	**الثدييات** طائفة الفقاريات الثديية المتميزة بجسد مغطى بالشعر وغدد لبنية منتجة للحليب الذي تغذي به صغارها.

المصطلـح	تعريف المصطلح
Notochord	**حبل ظهري** **قضيب مرن طولي يتشكل من الطبقة الوسطى (الميزوديرم) الظهرية ويتمركز بين المعي والحبل العصبي في كل أجنة الحبليات.**
Chordates	**الحبليات** **شعبة من المملكة الحيوانية بها حيوانات لافقارية وفقارية تمتلك حبلاً ظهرياً في احدى مراحل حياتها قد يستمر معها ليكون العمود الفقري مستقبلاً**
Lancelets	**السهيميات** **من الحبليات اللافقارية بها جميع صفات الحبليات ولا تمتلك عمود فقري**
Tunicates	**الغلاليات (القربيات)** **من الحبليات اللافقارية بها جميع صفات الحبليات ولا تمتلك عمود فقري**
Amphibians	**البرمائيات** **إحدى طوائف الحيوانات الحبلية التي لها مراحل مبكرة تعيش في البيئات المائية وتتنفس بواسطة فتحات خيشومية بينما تعيش أطوارها البالغة بين الماء والبر ولا تتنفس بواسطة الخياشيم ولكن بواسطة الجلد ورئات بدائية.**
Reptiles	**الزواحف** **أحدى طوائف الحيوانات الحبلية وتمتلك جلد حرشفي قوي يحمي الجسد ويمنع فقدان الماء ويمثلها السحالي والثعابين والسلاحف والتماسيح.**

تعريف المصطلح	المصطلـح
الطيور أحدى طوائف الحيوانات الحبلية التي تحورت حراشفها الجلدية إلى ريش ومعظمها يستطيع الطيران.	**Birds**
غدد لبنية غدد موجودة لدى إناث الثدييات تنتج الحليب اللازم لإرضاع صغارها.	**Mammary glands**
أحادية المسلك (المذرق / الفتحة) قسم من الثدييات التي تضع بيضاً ومن أمثلتها منقار البط (خلد الماء) وآكلات النمل الشوكية.	**Monotremes**
الثديات الجرابية (الكيسية) قسم من في الثدييات حيث تبقى أجنتها في الرحم لفترة وجيزة ثم تُولد في مرحلة مبكرة غير ناضجة و يحدث التكوين والنمو الجنيني بعد الولادة في جراب واقٍ ، ومن أمثلتها الكنغر.	**Marsupials**
الثديات المشيمية قسم الثدييات التي تحتفظ بصغارها في الرحم حتى يكتمل نموها وتكوينها الجنيني قبل أن تولد ، وتمثل معظم أنواع الثدييات .	**Placentals**

Gas Exchange تبادل الغازات

المصطلــــــــــــــــــــــح	تعريف المصطلـــــــح
Mechanisms Of Gas Exchange	آليات تبادل الغازات
Three Phases Of Gas Exchange	مراحل تبادل الغازات
Breathing	التنفس
Transport Of Oxygen And Carbon Dioxide In Blood	قل الاكسجين و ثاني اكسد الكربون في الدم
Body Tissues Take Up Oxygen And Release Carbon Dioxide	امتصاص انسجة الجسم للأكسجين و التخلص من ثاني اكسد الكربون
Cellular Respiration	التنفس الخلوي
Requires A Continuous Supply Of Oxygen And The Disposal Of Carbon Dioxide	تزويد مستمر بالأكسجين والتخلص من ثاني اكسد الكربون
Respiratory Surfaces Must Be Thin And Moist For Diffusion Of O_2 And CO_2	ينبغي للسطوح التنفسية ان تكون رقيقة ورطبة لانتشار الاكسجين وثاني اكسيد الكربون عبرها
Earthworms	ديدان الارض
Most Animals Have Specialized Body Parts That Promote Gas Exchange	تمتلك معظم الحيوانات اجزاء متخصصة بالجسم تقوم بعملية تبادل الغازات
Gills	لخياشيم
Tracheal Systems In Arthropods	اجهزة القصبات الهوائية في مفصليات الارجل
Tetrapods	رباعيات الارجل

Gas Exchange تبادل الغازات

المصطلـــــــــــــــــــح	تعريف المصطلـــــــح
Amphibians	البرمائيات
Reptiles	الزواحف
Mammals	الثديات
Extensions Of The Body	تمددات لسطح الجسم
Increase Surface To Volume Ratio	تزيد من نسبة السطح الى الحجم
Gas Exchange	تبادل الغازات
Ventilation	تهوية
Countercurrent Flow	التيار المعاكس
Advantages	فوائد
Higher Concentrations	تركيزات اكبر
Respiratory Surfaces	سطوح اجسامها التنفسية
Insect Tracheal Systems	الاجهزة القصبية للحشرات
Tiny Branching Tubes	انابيب دقيقة متفرعة
Air Is Piped Directly To Cells	يضخ الهواء مباشرة الى الخلايا
Evolved In Shallow Water	بدأت حياتها في المياه الضحلة
Diverged	تفرعت
Three Major Lineages	ثلاثة افرع رئيسية
Nonbird Reptiles	الزواحف غير الطائرة
Lower Metabolic Rates	ايضية منخفضة

Gas Exchange تبادل الغازات

المصطلـــــــــــــــــــــــــــــح	تعريف المصطلـــــــح
Inhaled Through	يستنشق الهواء ,
Nasal Cavity	التجويف الانفي
Filtered By Hairs And Mucus Surfaces	يرشح الهواء (من العوالق) عن طريق الشعر و الاسطح المخاطية
Air Is Warmed And Moisturized	تم تدفئة وترطيب الهواء
Air Is Sampled For Odors	يتم فرز الهواء من اجل تمييز الروائح
Nasal Cavity	التجويف الانفي،
Pharynx	البلعوم
Then Larynx, Past The Vocal Cords	الحنجرة مار بالا حبال الصوتية
Trachea	الى القصبات الهوائية
Cartilage Rings	مفتوحة بحلقات غضروفية
Paired Bronchi	الشعب الهوائية
Bronchioles	الشعيبات الهوائية
Alveoli,	الحويصلات الهوائية
Grapelike Clusters Of Air Sacs	عنقود من الاكياس الهوائية
High Surface Area Of Capillaries	مساحة السطح العالية للشعيرات الدموية
High Surface Area Of Alveoli	مساحة السطح العالية للحويصلات الهوائية
O_2 Diffuses Into The Blood	ينتشر الاكسجين الى الدم
CO_2 Diffuses Out Of The Blood	يطرد ثاني اكسيد الكربون خارج الدم

Gas Exchange تبادل الغازات

المصطلـــــــــــــــــــــــــــح	تعريف المصطلـــــــح
Mucus And Cilia	المخاط والأهداب
Protect The Lungs	تحمي الرئتين
Damaged By Smoking	ان تتلف بالتدخين
Lung Cancer	سرطان الرئة
Heart Disease	امراض القلب
Emphysema	ضيق التنفس
Risk Of Heart Attacks And Strokes	يزيد نوبات القلب والجلطات
Raises Blood Pressure	يرفعِ من ضغط الدم
Increases Harmful Types Of Cholesterol	يزيد من التعرض لأنواع الكلسترول الضارةالكلسترول الضارة
Accidents, Alcohol, Drug Abuse, HIV, And Murders Combined	يفوق الموت من الحوادث , تعاطي الكحول والإدمان على المخدرات و الايدز و الاغتيالات
Breathing	التنفس
Alternate Inhalation And Exhalation Of Air (Ventilation)	تعاقب شهيق وزفير الهواء (التهوية)
Inhalation	الشهيق
Rib Cage Expands	يتمدد (يتسع) القفص الصدري
Diaphragm Moves Downward	ينخفض الحجاب الحاجز
Pressure Around Lungs Decreases	ينخفض الضغط حول الرئة

Gas Exchange تبادل الغازات

المصطلـــــــــــــــــــــــح	تعريف المصطلــــــح
Air Is Drawn Into The Respiratory Tract	يسحب الهواء الى الممرات التنفسية
Exhalation	الزفير
Rib Cage Contracts	ينقبض (يضيق) القفص الصدري
Diaphragm Moves Upward	يرتفع الحجاب الحاجز الى اعلى
Pressure Around The Lungs Increases	يزداد الضغط حول الرئتين
Air Is Forced Out Of The Respiratory Tract	ويطرد الهواء خارج الممرات التنفسية
Automatic Control	التحكم الاوتوماتيكي
Breathing Control Centers	مراكز التحكم بالتنفس
Respond To CO_2 Levels	تستجيب لمستويات ثاني اكسيد الكربون في الدم
Drop In Blood Ph Increases	انخفاض الاس الهيدروجيني في الدم يزيد
Rate And Depth Of Breathing	معدل وعمق التنفس
Transport Of Gases In The Human Body	نقل الغازات في جسم الانسان
Heart Pumps Blood To Two Regions	يضخ القلب الدم الى منطقتين
Right Side Pumps Oxygen-Poor Blood To The Lungs	يضخ الجانب الايمن الدم الفقير الى الاكسجين الى الرئتين
Left Side Pumps Oxygen-Rich Blood To The Body	ضخ الجانب الايسر الدم الغني بالأكسجين الى بقية اجزاء الجسم

Gas Exchange تبادل الغازات

المصطلـــــــــــــــــــــــــح	تعريف المصطلــــــــح
In The Lungs, Blood Picks Up O_2 And Drops Off CO_2	في الرئتين ، يأخذ الدم الاكسجين و يطرد ثاني اكسيد الكربون
In The Body Tissues, Blood Drops Off O_2 And Picks Up CO_2	في انسجة الجسم , يترك الدم الاكسجين ويأخذ ثاني اكسيد الكربون
O_2 Moves From The Alveoli Of The Lungs Into The Blood	يتحرك الاكسجين من الحويصلات الهوائية للرئتين الى الدم
CO_2 Moves From The Blood Into The Alveoli Of The Lungs	يتحرك ثاني اكسيد الكربون من الدم الى الحويصلات الهوائية للرئتين
Tissues Have More CO2 And Less O2 Than In The Blood	بها ثاني اكسيد الكربون اكثر وأكسجين اقل مما هو في الدم
CO2 Moves From The Tissues Into The Blood	يتحرك ثاني اكسيد الكربون من الانسجة الى الدم
O2 Moves From The Blood Into The Tissues	يتحرك الاكسجين من الدم الى الانسجة

Gas Exchange تبادل الغازات

المصطلـــــــــــــــــح	تعريف المصطلـــــح
Animals Transport O_2 Bound To Proteins	معظم الحيوانات تنقل الاكسجين المرتبط ببروتينات
Respiratory Pigments	الصبغات التنفسية
Copper-Containing Pigment	الصبغات المحتوية على النحاس
Mollusca	لرخويات
Iron-Containing Hemoglobin	الهيموجلوبين المحتوي على الحديد
Vertebrates	معظم الفقاريات
Invertebrates	اللافقاريات
Buffers Blood	ويعادل الدم
Heme Group	مجموعة الهيم
CO_2 In The Blood Is Transported As	ينقل معظم ثاني اكسيد الكربون في الدم
Bicarbonate Ions In The Plasma	هيئة ايونات البيكربونات في البلازما

Circulation الدورة الدموية

المصطلـــــــــــــــــــــــــــــح	تعريف المصطلــــــح
Mechanisms Of Internal Transport	آليات النقل الداخلي
Nutrients	مواد غذائية
Gas Exchange	تبادل الغازات
Removal Of Wastes	التخلص من الفضلات
Diffusion	عملية الانتشار
Inadequate For Large And Complex Bodies	ليست كافية بالنسبة للأجسام الكبيرة والمعقدة
An Internal Transport System Assists Diffusion By Moving Materials Between	يساعد جهاز النقل الداخلي عملية الانتشار بنقل المواد وتحريكها بين
Surfaces Of The Body	سطح الجسم
Internal Tissues	الأنسجة الداخلية
Gastrovascular Cavity	التجويف المعدي الوعائي
Cnidarians And Flatworms	في شعبة سينيداريا والديدان
Digestion	في عملية الهضم
Distribution Of Substances	وتوزيع المواد
Circulatory System	يتكون الجهاز الدوري

Circulation الدورة الدموية

تعريف المصطلـــــــح	المصطلـــــــــــــــــــــــح
الأوعية الدموية	**Blood Vessels**
الأجهزة الدورية المفتوحة	**Open Circulatory Systems**
مفصليات الأرجل	**Arthropods**
الرخويات	**Molluscs**
أوعية ذات نهايات مفتوحة	**Open-Ended Vessels**
نغمر الخلايا مباشرة في الدم	**Cells Directly Bathed In Blood**
الأجهزة الدورية المغلقة	**Closed Circulatory Systems**
الفقاريات, ديدان الأرض, أسماك الحبار, الإخطبوط	**Vertebrates, Earthworms, Squids, Octopuses**
ينحصر الدم في الأوعية	**Confined To Vessels**
يضخ القلب الدم عبر الشرايين إلى الشعيرات	**A Heart Pumps Blood Through Arteries To Capillaries**
تعيد الأوردة الدم إلى القلب	**Veins Return Blood To Heart**
قلب ذو غرفتين	**Two-Chambered Heart**
دائرة مفردة	**Single Circuit**
الشعيرات الخيشومية	**Gill Capillaries**

Circulation الدورة الدموية

المصطلـــــــــــــــــــــــح	تعريف المصطلـــــــــح
Systemic Capillaries	إلى شعيرات الجهاز الدوري
Double Circulation	دورة دموية مزدوجة
Separate Pulmonary & Systemic Circuits	دورتين منفصلتين وهما الرئوية والجهازيه
Three-Chambered Hearts	قلوب ذات ثلاث غرف
Amphibians, Turtles, Snakes, Lizards	البرمائيات, السلاحف, الثعابين, السحالي
Two Atria And One Undivided Ventricle	بطين واحد غير مُجزأ أُذينان
Permits Blood Diversion Away From Lungs When Diving	يسمح بانحراف الدم بعيداً عن الرئة أثناء الغوص
Some Blood From Body And Lungs Mixes In The Ventricle When Not Diving	بعض الدم من الجسم والرئتين يختلطا في البطين في حالة عدم الغوص
Four-Chambered Hearts	القلوب ذات الأربع غرف
Crocodilians, Birds, Mammals	التماسيح, الطيور, الثدييات
Two Circuits That Do Not Mix	دورتان لا تختلطان مع بعضهما البعض
Right Side Pumps Blood From Body To Lungs	يضخ الجانب الأيمن الدم من الجسم إلى الرئة
Higher Blood Pressure	ضغط الدم الأعلى
More Efficient Movement Of Blood	يدعم الحركة الأكثر كفاءة للدم

Circulation الدورة الدموية

المصطلـــــــــــــــــــــــح	تعريف المصطلـــــــح
Needed In Endothermic Animals	مطلوب في الحيوانات داخلية الحرارة
The Human Cardiovascular System	الجهاز القلبي الوعائي للإنسان
Blood Flow Through The Double Circulatory System Of Humans	يتدفق الدم عبر الجهاز الدوري المزدوج للإنسان
Mammalian Heart	قلب الثدييات
Two Thin-Walled Atria	أُذينان رفيعة الجُدر
Thick-Walled Ventricles	بطينين سميكة الجُدر
Cardiac Output	السعة القلبية
Amount Of Blood/Minute Pumped Into Systemic Circuit	كمية الدم التي يضخها القلب في الدورة الجهازيه في الدقيقة
Heart Rate	معدل دقات القلب
Heart Valves	صمامات القلب
Heart Murmur	لغط القلب
Pacemaker (SA Node)	عضلة تنظيم دقات القلب (العقدة الجيب اُذينية)
Rate Of Heart Contractions	معدل انقباضات القلب
Generates Electrical Signals In Atria	تولد الإشارات الكهربائية في الأُذنين
AV Node	العقدة الأُذين بطينة

Circulation الدورة الدموية

المصطلــــــــــــــــــــــح	تعريف المصطلـــــــح
Relays These Signals To The Ventricles	تنقل هذه الإشارات للبطينين
Heart Attack	النوبة القلبية
Damage To Cardiac Muscle	هي تلف عضلة القلب
Blocked Coronary Artery	شريان تاجي مسدود
Stroke Death Of Brain Tissue	موت نسيج المخ
Atherosclerosis	مرض تصلب الشرايين
Capillaries	الشعيرات الدموية
Thin Walls	جدران رفيعة
Narrow	ضيقة
Increase Surface Area For Gas And Fluid Exchange	يزيد من مساحة السطح لتبادل الغازات والسوائل
Arteries And Veins	لشرايين والأوردة
Single Layer Of Epithelial Cells	مبطنة بطبقة واحدة من الخلايا الطلائية
Elastic Fibers Permit Recoil After Stretching	تسمح الألياف المطاطة بالارتداد إلى الحالة الطبيعية بعد الشد
Veins Have One-Way Valves That Restrict Backward Flow	الأوردة لها صمامات ذات اتجاه واحد والتي تمنع ارتداد الدم
Blood Pressure	ضغط الدم

Circulation الدورة الدموية

المصطلـــــــــــــــــــــــــــــح	تعريف المصطلـــــــــح
Depends On Cardiac Output And Resistance Of Vessels	وتعتمد على السعة القلبية ومقاومة الأوعية
Systolic Pressure	الضغط الانقباضي
Caused By Ventricular Contraction	نتيجة لانقباض البطين
Diastolic Pressure	الضغط الانبساطي
Low Pressure Between Contractions	نتيجة للضغط المنخفض بين الانقباضات
Structure And Function Of Blood	تركيب ووظيفة الدم
Plasma	لبلازما
Various Inorganic Ions	أيونات غير عضوية متعددة
Proteins, Nutrients	بروتينات, مواد غذائية
Wastes, Gases	فضلات, غازات
Hormones	هرمونات
Red Blood Cells (Erythrocytes)	خلايا الدم الحمراء
White Blood Cells (Leukocytes)	خلايا الدم البيضاء
Anemia	الأنيميا "فقر الدم"
Abnormally Low Amounts Of Hemoglobin Or Red Blood Cells	كميات منخفضة بصورة غير طبيعية من الهيموجلوبين أو خلايا الدم الحمراء

Circulation الدورة الدموية

المصطلـــــــــــــــــــــــح	تعريف المصطلـــــــــح
Causes Fatigue Due To Lack Of Oxygen In Tissues	تسبب الإجهاد نتيجة لقلة الأكسجين في الأنسجة
Erythropoietin Hormone (EPO) Regulates Red Blood Cell Production	هرمون المولد لخلايا الدم الحمراء يقوم بتنظيم عملية انتاج كرات الدم الحمراء
Some Athletes Artificially Increase Red Blood Cell Production By Injecting Erythropoietin Which Can Lead To	يقوم بعض الرياضيين بزيادة انتاج خلايا الدم الحمراء بصورة صناعية وذلك بحقن الهرمون المولد لخلايا الدم الحمراء والذي يمكن أن يؤدي إلى:
Clotting	التجلط
Stroke	سكتة دماغية
Heart Failure	ذبحة صدرية
Death	الموت
When A Blood Vessel Is Damaged	عند تلف الوعاء الدموي
Platelets Help Trigger The Conversion Of Fibrinogen To Fibrin	تساعد الصفائح الدموية على استهلال تحول الفيبرينوجين "مولد الألياف" إلى فيبرين
Which Forms A Clot That Plugs The Leak	والذي يُكون جلطة تسد النزيف
Blood-Clotting Process	عملية تجلط الدم
Platelets Adhere To Exposed Connective Tissue	تلتصق الصفائح الدموية بنسيج ضام ظاهر
Platelets Form A Plug	تكون الصفائح الدموية سُدادة
Fibrin Clot Traps Blood Cells	الفيبرين تجتذب الخلايا الدموية

Control of Body Temperature and Water Balance
التحكم في درجة حرارة الجسم و الاتزان المائي

المصطلــــــــــــــــــــــح	تعريف المصطلـــــــح
Homeostasis	الاتزان الحيوي
Maintenance Of Steady Internal Conditions	القدرة على الحفاظ على ظروف وأحوال داخلية مستقرة
Fluctuations	التقلبات
Thermoregulation	التنظيم الحراري
Osmoregulation	التنظيم الاسموزي
Excretion	لاخراج
Nitrogen-Containing Wastes	المخلفات المحتوية على النتروجين
Thermoregulation	التنظيم الحراري
Internal Temperature Within A Tolerable Range	المحافظة على درجة حرارة الجسم الداخلية ضمن مدى يمكن تحمله
Ectothermic	خارجية الحرارة
Endothermic	داخلية الحرارة
Conduction	التوصيل
Convection	الحمل الحراري
Radiation	الاشعاع
Evaporation	التبخير

Control of Body Temperature and Water Balance

التحكم في درجة حرارة الجسم و الاتزان المائي

المصطلــــــــــــــــــح	تعريف المصطلــــــح
Mechanisms Of Heat Exchange	اليات تبادل الحرارة
Adaptations Promote Thermoregulation	التكيفات التي تشجع على التنظيم الحراري
Increased Metabolic Heat Production	زيادة انتاج الحرارة الايضية
Insulation	العزل
Circulatory Adaptations	التكيفات الخاصة بالدورة الدموية
Evaporative Cooling	التبريد بالتبخر
Sweating	التعرق
Panting	للهث
Behavioral Responses	الاستجابات السلوكية
Osmoregulation and Excretion	التنظيم الاسموزي والإخراج
Osmoconformers	الكائنات ذات التوافق الاسموزي
Same Internal Solute Concentration As Seawater	نفس تركيز المواد الذائبة الداخلية كمياه البحر
Marine Invertebrates Are Osmoconformers	اللافقاريات البحرية كائنات ذات توافق اسموزي

Control of Body Temperature and Water Balance

التحكم في درجة حرارة الجسم و الاتزان المائي

المصطلـــــــــــــــــــــــــــــح	تعريف المصطلـــــــح
Osmoregulators Control Their Solute Concentrations	الكائنات ذات التنظيم الاسموزي لها القدرة على التحكم في تراكيز موادها المذابة
Saltwater Fish	اسماك المياه المالحة
Land Animals	حيوانات اليابسة
Nitrogenous Wastes	المخلفات النتروجينية
1-Ammonia (Nh3)	امونيا (غاز النشادر)
Urea	البولينا
Excretory System	الجهاز الاخراجي
Expels Wastes	يطرد المخلفات
Regulates Water Balance	ينظم الاتزان المائي
Regulates Ion Balance	ينظم الاتزان الايوني
Nephrons	(النفرونات) الوحدات البولية
Functional Units Of The Kidneys	الوحدات الوظيفية للكلى
Extract A Filtrate From The Blood	استخلاص المواد الراشحة من الدم
Refine The Filtrate To Produce Urine	تنقية المواد الراشحة لإنتاج البول
Urine	البول

Control of Body Temperature and Water Balance

التحكم في درجة حرارة الجسم و الاتزان المائي

المصطلـــــــــــــــــــــــــــــــــح	تعريف المصطلـــــــح
Ureters Drain The Kidneys	يفرغ الحالبان الكليتين
Stored In The Urinary Bladder	يخزن في المثانة البولية
Expelled Through The Urethra	يطرح من خلال المجرى البولي
Filtration	الترشيح
Blood Pressure Forces Water And Many Small Solutes Into The Nephron	يدفع ضغط الدم الماء و العديد من المواد المذابة الصغيرة الى الوحدة البولية
Reabsorption	اعادة الامتصاص
Valuable Solutes Are Reclaimed From The Filtrate	يتم استعادة المواد الذائبة النافعة من الراشح
Secretion	الافراز
Excess H^+ And Toxins Are Added To The Filtrate	يضاف الفائض من ايون الهيدروجين و السموم الى الراشح
Excretion	الاخراج
Final Product, Urine, Is Excreted	اخراج المنتج النهائي وهو البول
Reabsorption In The Proximal And Distal Tubules Removes Nutrients, Salt, Water	يزيح اعادة الامتصاص في الانيبيبات القريبة والبعيدة المواد المغذية والملح والماء
pH is regulated by	يتم تنظيم الاس الهيدروجيني

Control of Body Temperature and Water Balance

التحكم في درجة حرارة الجسم و الاتزان المائي

المصطلـــــــــــــــــــــــــــــــح	تعريف المصطلـــــــح
High Nacl Concentration	تركيز كلوريد الصوديوم العالي
Antidiuretic Hormone (ADH)	الهرمون المضاد للتبول
Regulates The Amount Of Water Excreted By The Kidneys	ينظم كمية الماء التي يتم التخلص منها عن طريق الكليتين
Compensating For Kidney Failure	التعويض عن الفشل الكلوي
A Dialysis Machine	جهاز غسل الكلى
Removes Wastes From The Blood	ازاحة المخلفات من الدم
Solute Concentration	تركيز المواد المذابة
Excretion In Plants	الإخراج فى النبات
Excretion Of Gases	إخراج الغازات
Exit	لخروجه
Penetrate External Cell Surfaces	النفاذ مباشرة عبر سطوح الخلايا الخارجية
Guttation	الإدماع

Control of Body Temperature and Water Balance
التحكم في درجة حرارة الجسم و الاتزان المائي

المصطلــــــــــــــــــــح	تعريف المصطلــــــــح
Secretion	إفراز
Hydathodes	الثغور المائية
Humid Environment.	البيئة الرطبة
Terrestrial Plants	النباتات الأرضية
Deamination	بعملية نزع الأمين
Aquatic Plants	النباتات المائية
Converted	تحويل
Salt Glands	بالغدد الملحية
Halophytes	غدد ملحية

Reproduction

المصطلـــــح	تعـريف المصطـلح
Angiosperms	كاسيات البذور
Sporophyte :The Diploid Generation.	النابت البوغي :الجيل ثنائي العدد الكروموزومي.
Gametophyte: The Haploid Generation.	النابت الجاميطي :الجيل أحادي العدد الكروموزومي.
Pollen Grain: The Male Gametophyte.	حبه لقاح :النابت الجاميطي المذكر.
Embryo Sac: The Female Gametophyte.	الكيس الجنيني: النابت الجاميطي الأنثوي.
Endosperm: Central Cell Within The Embryo Sac Has Two Nuclei.	الإندوسبيرم :خلية واحدة مركزية داخل الكيس الجنيني لها نواتان.
Pollination :Transfer Of Pollen From Anther To Stigma.	عملية التلقيح: نقل حبوب اللقاح من المُتك إلى الميسم.
Double Fertilization: One Sperm Fertilizes The Egg To Produce A Zygote, The Other Fuses With The Central Cell Nuclei To Produce $3n$ Endosperm.	الاخصاب المزدوج: تقوم إحدى الخليتين المنويتين بتخصيب البيضة لإنتاج اللاقحة, و تقوم الأخرى بالاندماج مع النواة الخلية المركزية لتنتج نسيج الإندوسبيرم ثلاثي العدد الكروموزومي ($3n$).
Seed Dormancy: Embryo Growth And Development Are Suspended.	كمون البذرة: توقف نمو و تكوين الجنين.
Two Cotyledons = Eudicot Seeds	فلقتان
Single Cotyledon = Monocot Seeds	فلقة واحدة

Reproduction

المصطلـــــح	تعـريف المصطـلح
Fruit: Developed Ovary.	الثمرة: مبيض مكتمل النمو.
Germination	الإنبات
Asexual Reproduction: One Parent Produces Genetically Identical Offspring.	التكاثر اللاجنسي: ينتج أحد الوالدين ذرية متماثلة وراثياً .
Hermaphroditism: One Individual With Male And Female Reproductive Systems.	الخنوثة: فرد واحد بأجهزة تكاثر ذكرية وأنثوية .
External Fertilization: Eggs And Sperm Are Discharged Near Each Other.	الإخصاب الخارجي: يتم إطلاق البيض والحيوانات المنوية بالقرب من بعضها البعض.
Internal Fertilization: Sperm Is Deposited In Or Near The Female Reproductive Tract.	الإخصاب الداخلي: يتم إيداع الحيوانات المنوية في أو قريباً من القناة التناسلية للأنثي .
Gonads: Where Gametes Are Produced.	المناسل: حيث يتم انتاج الجاميطات.
Ovaries: Contain Follicles That Nurture Eggs And Produce Sex Hormones.	المبايض: تحتوي على حويصلات والتي تقوم بـ تغذية البيض وانتاج هرمونات الجنس.
Testes (Singular *Testis*): Produce Sperm And Male Hormones.	الخصي (مفردها خصية): تنتج الحيوانات المنوية هرمونات الذكورة .
Epididymis: Stores Sperm As They Develop Further	البربخ: يتم فيه تخزين الحيوانات المنوية وإنضاجها.

Reproduction

المصطلـــــــح	تعـريف المصطـلح
Spermatogenesis: Formation Of Sperms.	عملية تكوين الحيوانات المنوية
Oogenesis: Formation Of Ovum.	عملية تكوين البيض
Menstrual Cycle	الدورة الشهرية
Menstruation	الحيض
Corpus Luteum	الجسم الأصفر
Endometrium	بطانة الرحم
Cleavage: Rapid Series Of Cell Divisions.	التفلج: هو سلسلة سريعة من الانقسامات الخلوية.
Gastrulation: Cells Migrate And Basic Body Plan Of Three Layers Is Established.	التبطن: هجرة الخلايا و يتم تأسيس الخطة الأساسية للجسم ذو الثلاث طبقات .

بسم الله الرحمن الرحيم

كيفية الدخول إلى موقع السنة التحضيرية لمقرر علم الأحياء العام 1 (Bio 110)

من الموقع الرئيسي للجامعة:

1. يتم اختيار كلية العلوم من قائمة الكليات
2. اختيار قسم علم الأحياء من قائمة الأقسام العلمية
3. اختيار السنة التحضيرية
4. اختيار المحاضرات النظرية
5. تحميل الملفات بصيغة pdf

http://bio.kau.edu.sa/Default.aspx?Site_ID=13010&Lng=AR

كيفية الدخول إلى الموقع التفاعلي للتدريب علي أسئلة مقرر علم الأحياء العام 1 (Bio 110)

http://sciences.kau.edu.sa/Pages-Biology110-homepag.aspx

هام جدا

أسئلة الاختبارات تأتي من الموقع التفاعلي ومن المحاضرات النظرية فقط والقسم غير مسئول عن أي نماذج أو مذكرات تباع في أي مكان

General Biology (1) علم الأحياء العام (1)

جـدول توزيع محاضرات مقرر الأحياء العامه (Bio 110)

عنوان المحاضرات النظرية	الأسبوع
Chapter 1: Exploring Life	الاسبوع الأول
Chapter 2: The Chemical Basis of Life	الاسبوع الثاني
Chapter 3: The Molecules of Cells	الاسبوع الثالث
Chapter 4: The Cells	الاسبوع الرابع
Chapter 5: The Tissues	الاسبوع الخامس
الاختبار الدوري الاول (30 درجة)	الاسبوع السادس
Chapter 6: Bioenergetics	الاسبوع السابع
Chapter 7: Biodiversity	الاسبوع الثامن
Chapter 8: Nutrition	الاسبوع التاسع
الاختبار الدوري الثاني (30 درجة)	الاسبوع العاشر
Chapter 9: Excretion	الاسبوع الحادي عشر
Chapter 10: Gas exchange	الاسبوع الثاني عشر
Chapter 11: Reproduction	الاسبوع الثالث عشر
Chapter 12: Genetics	الاسبوع الرابع عشر
الاختبار النـهائي (40 درجة)	

GENERAL BIOLOGY 1

(Bio 110)

Chapter 1 Exploring Life

Introduction to Biology

What is Biology?

- **Biology** is the study of all living things
- **Living things are called organisms**
- **Organisms include bacteria, protists, fungi, plants, & animals**

Biology:

Is the scientific study of life in all its living forms, plants, animals and microorganisms, including man

The term “Biology” derived from

bios **= life**

and

logos **= science**

All Living Things Share Common Characteristics known as:

The Characteristics of Life

The Characteristics of Life

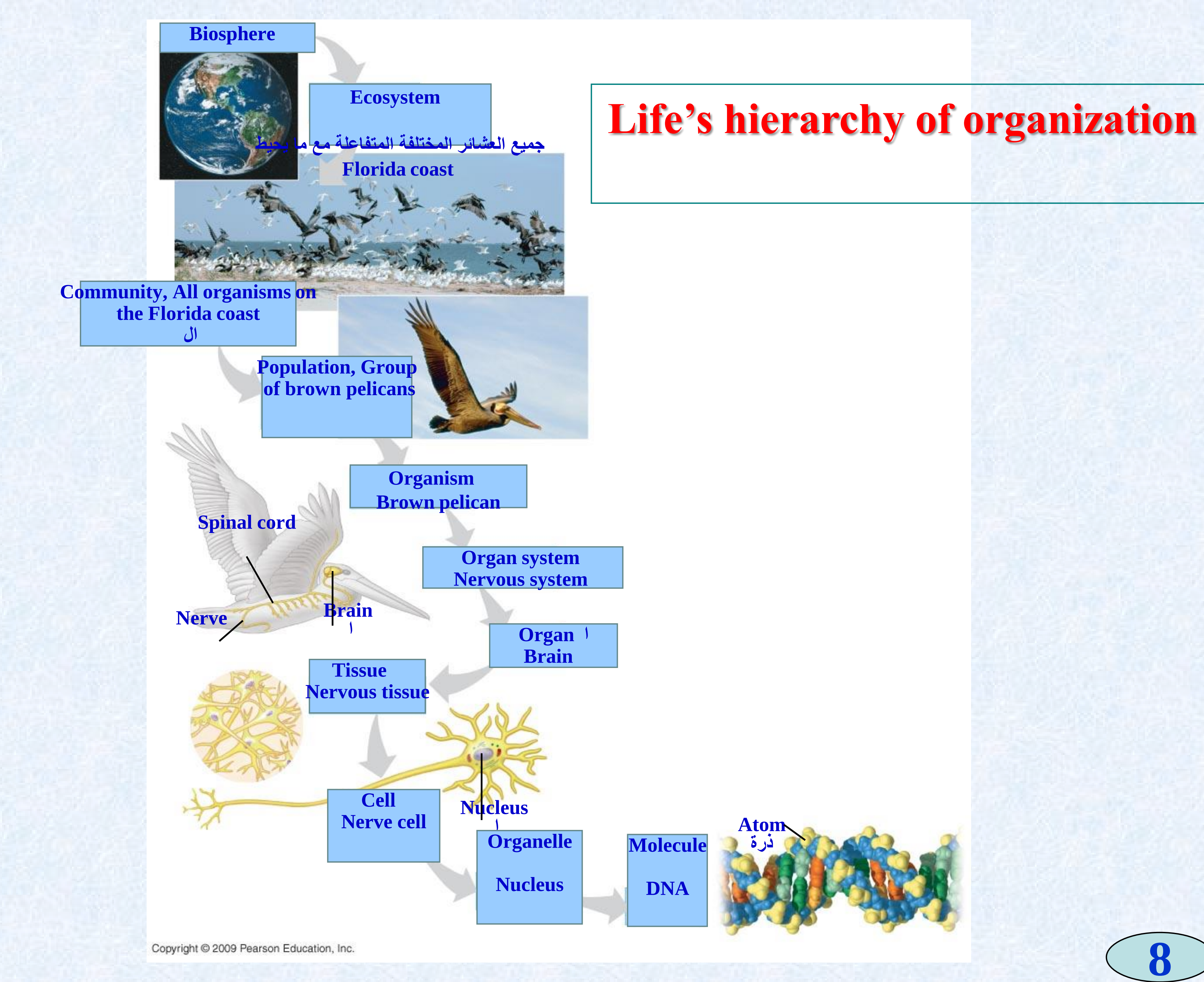
1. Order (organization):

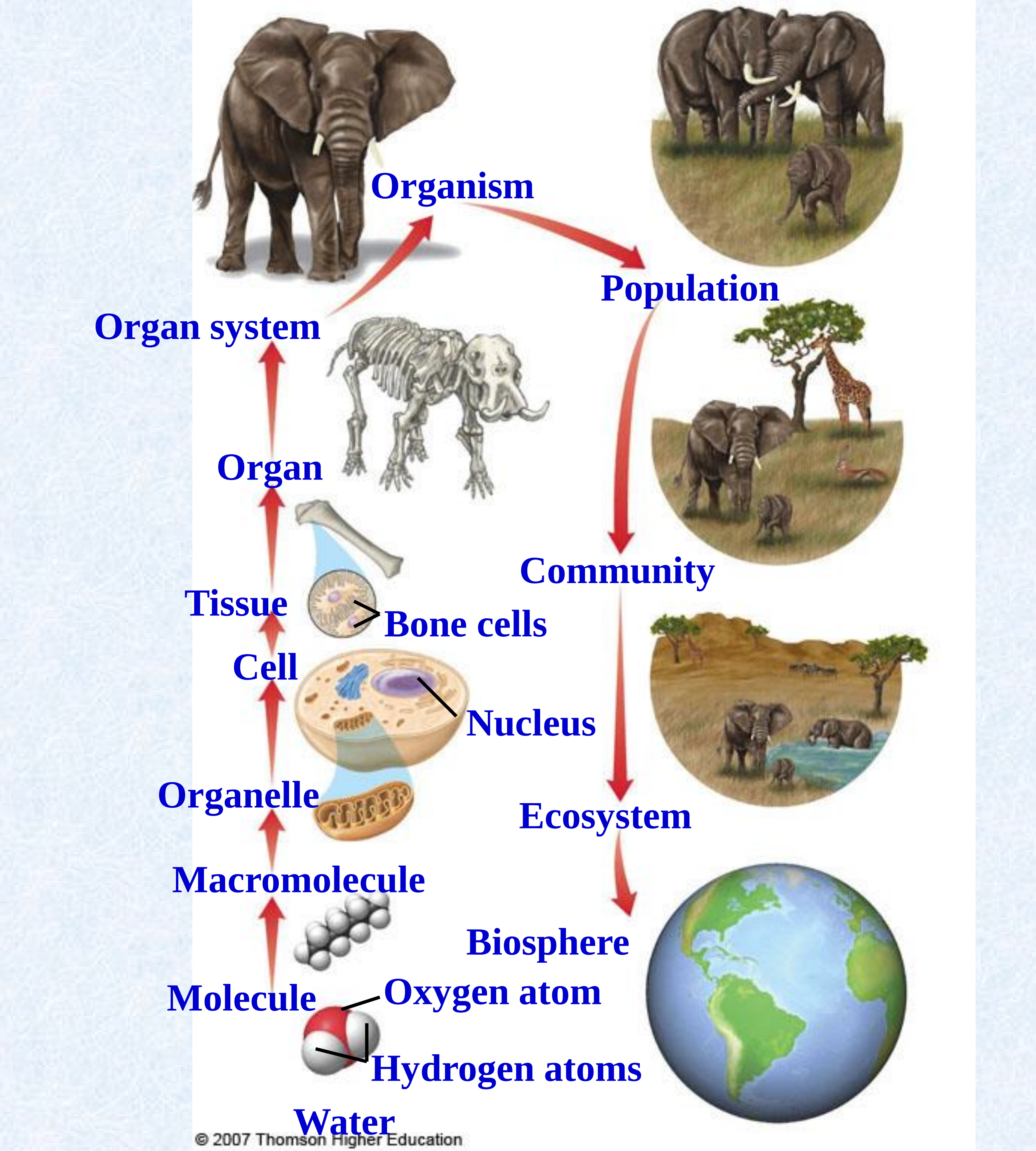
Living organisms are organized in several levels of increasing complexity best described as a :

Hierarchy of life levels.

Atoms	**Molecules**	**Organelles**
Cells – life starts here		
Tissues	**Organs**	**System**
Organism	**Population**	**Community**
Ecosystem	**Biosphere**	

Life's hierarchy of organization




Organism
Population
Organ system
Organ
Community
Tissue
Bone cells
Cell
Nucleus
Organelle
Ecosystem
Macromolecule
Biosphere
Oxygen atom
Molecule
Hydrogen atoms
Water
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Hierarchy of life levels.

- **Atom**
- **Molecules - clusters of atoms**
- **Organelles - membrane-bound structures with different jobs inside Cells**
- **Cells - life starts here. The simplest entity that has all the properties of life**
- **Tissues - made of groups of similar cells that carries out a particular function in an organism**
- **Organs - A structure consisting of two or more tissues that performs specialized functions within an organism**
- **Organ systems - have specific functions; are composed of organs that carries out a particular function in an organism**

Life's hierarchy of organization

- **Organism:** **An individual living thing that can react to stimuli, reproduce, grow and maintain homeostasis**
- **Population:** **All the individuals of a species only interbreed with each other within a specific area**
- **Community:** **The array of organisms (different populations) living in a particular ecosystem**
- **Ecosystem:** **All the organisms (communities) living in a particular area**
- **Biosphere:** **All the environments (ecosystems) on Earth that support life**

The Characteristics of Life

2. **Metabolism:**

   Sum of all the chemical reactions in an organism. Organized synthesis and break down of molecules; can produce energy to power life processes.

3. **Energy processing:**

   Acquiring energy and transforming it to a form useful for the organism through metabolism

4. **Motility:**

   Organisms can move themselves or their parts.

5. **Responsiveness:**

   An ability to respond to environmental stimuli

The Characteristics of Life

6. **Regulation:**

   An ability to maintain an internal environment consistent with life (Homeostasis) Within The Ranges Required For Life. Stable internal conditions of pH, temperature, water balance, etc

7. **Development:**

   Develop from simple to more complex organism.

8. **Reproduction:**

   The ability to perpetuate the species, genes are passed from parent to offspring; genes control an organism's phenotype

The Characteristics of Life

9. Evolution:

Evolution is the process of change that transforms life. Populations change over time as they adapt to their environment.

10. Adaptations:

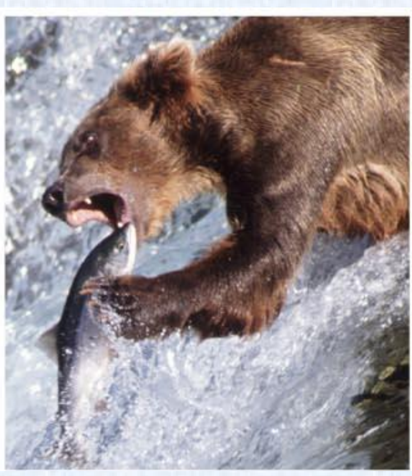
The innate fitness of an organism for its environmental condition. The environment selects organisms with traits that are best suited for an organisms environment (natural selection). The leopard is an excellent example of an organism adapted to its environment.

Adaptations are the result of evolution

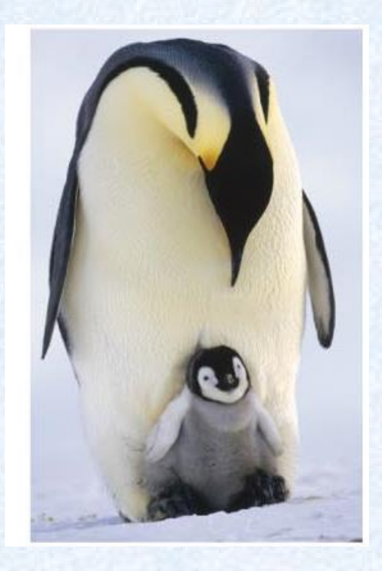

(1) Order


(2) Regulation


(3) Growth and development


(4) Energy processing


(5) Response to the environment


(6) Reproduction


(7) Evolutionary adaptation

Some important properties of life

Some important properties of life

All living things exhibit complex but ordered Organization, as seen in the highly ordered Structure of a sunflower



(1) Order

Some important properties of life

The environment outside an organism (a living thing) frequently changes, but mechanisms regulate the organism's internal environment, keeping it within limits that sustain life



(2) Regulation

For example, a jackrabbit can adjust its body temperature by regulating The amount of blood flowing through its ears. When the rabbit's body temperature rises, more blood flows through the vessel in its ears, allowing excess heat to be released to the air.

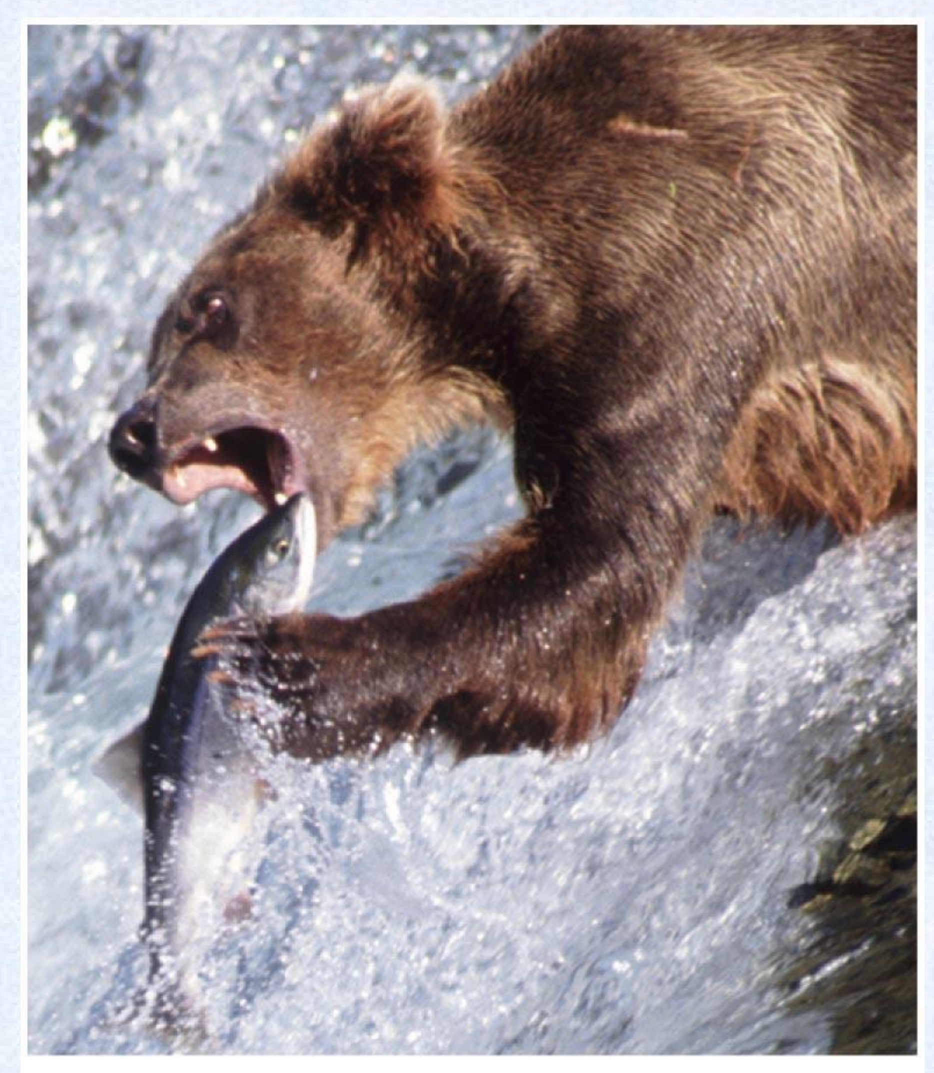
Some important properties of life



(3) Growth and development

Information carried by genes the units of inheritance that transmit information from parents To offspring – controls the pattern of growth and development in all organisms, including the Nile crocodile

Some important properties of life



(4) Energy processing
Metabolism

Organisms take in energy and transform it in performing all of life's activities

For example, when this bear eats the fish, it will use the chemical energy stored in the fish to power its own activities and chemical reactions (metabolism)

Some important properties of life



(5) Response to the environment

All organisms respond to environmental stimuli

For example, a Venus flytrap closes its trap in response to the environmental stimulus of an insect landing on it

Some important properties of life



Organisms reproduce their own kind, by producing offspring.
This Emperor Penguin is protecting its baby.
By reproduction survival of the specie, not extinction, is achieved

Some important properties of life



(7) Evolutionary adaptation

Reproduction underlies the capacity of populations to change (evolve) over time

For example, the appearance of the pygmy seahorses has evolved in the way that camouflage the animal in its environment

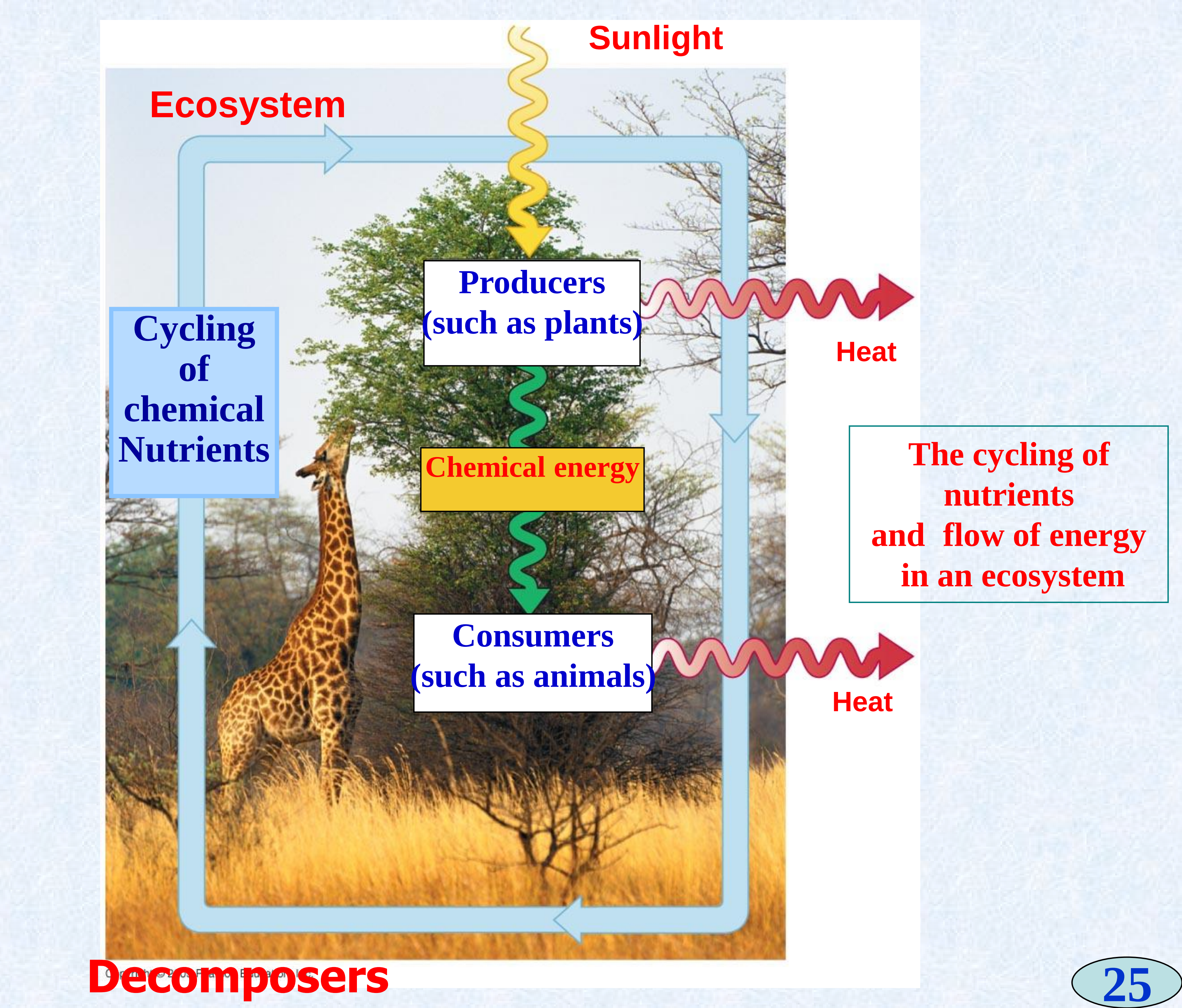
Living organisms interact with their environments, exchanging matter and energy

- **Life requires interactions between living and nonliving components**
  - **Photosynthetic organisms provide food and are called Producers**
  - **Others eat plants (or animals that profit from plants) and are called Consumers**
  - **Decomposers: Recycle all organic materials (Dead plants and animals)**
- **The nonliving components are chemical nutrients required for life**

Living organisms interact with their environments, exchanging matter and energy

- **To be successful, an ecosystem must accomplish two things:**
  - **Recycle chemicals necessary for life**
  - **Move energy through the ecosystem**

Energy enters as light and exits as heat



Sunlight
Ecosystem
Producers
(such as plants)
Heat
Cycling of chemical Nutrients
Chemical energy
Consumers
(such as animals)
Heat
Decomposers
The cycling of nutrients and flow of energy in an ecosystem

THE PROCESS OF SCIENCE

Scientific Method

Steps in the Scientific Method

- Observation
- Hypothesis
- Experiment
- Data Collection
- Conclusion
- Retest



- **Two approaches are used to understand natural causes for natural phenomena**

1. **Discovery based science:**

- **Results that have been found from actually having carried out the experiment or investigation.**
- **Uses verifiable observations and measurements to describe science.**

2. **Hypothesis- based science:**

- **An educated guess by a scientist of what will happen during an experiment or investigation.**
- **Uses the data from discovery science to explain science. This requires proposing and testing of hypotheses.**

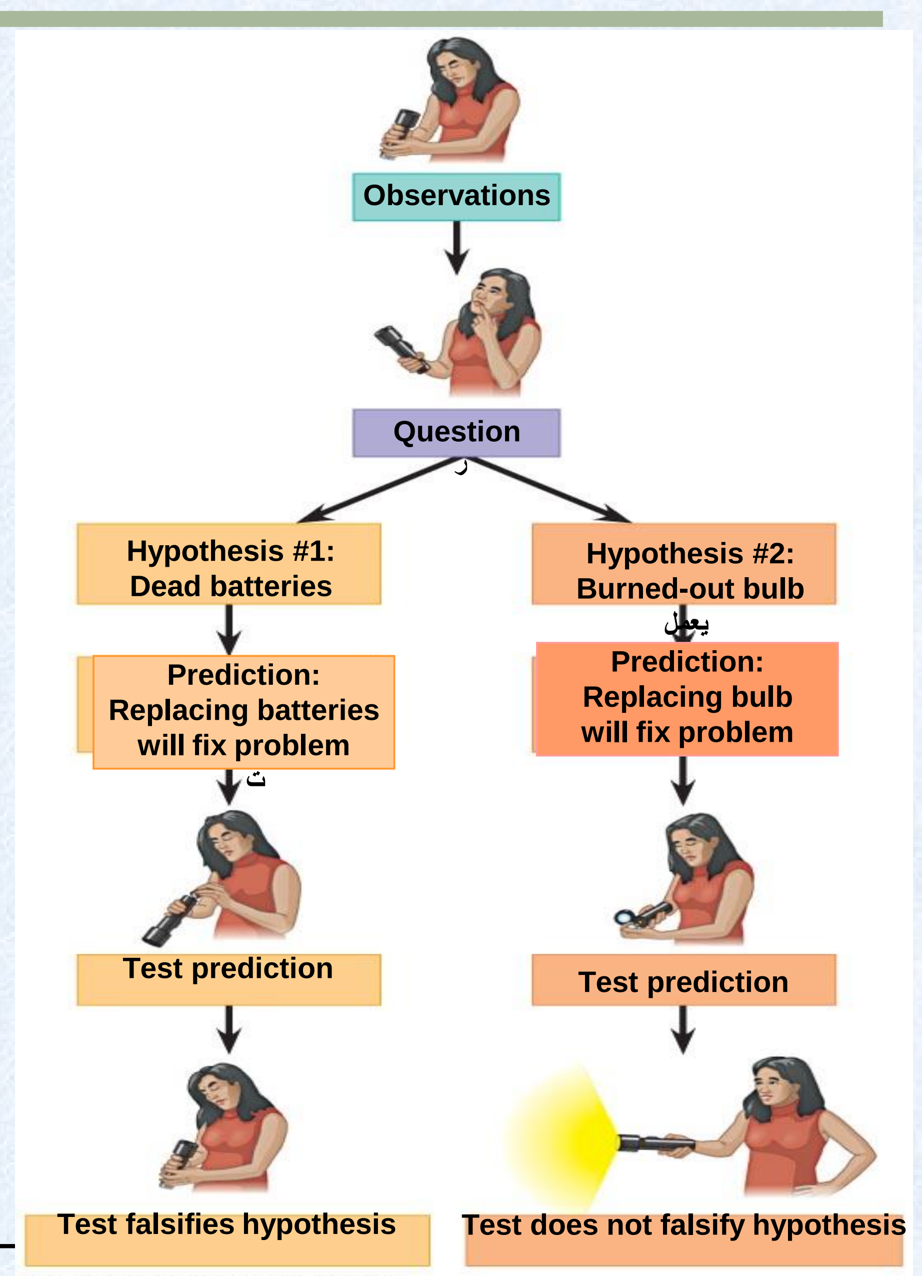
- **There is a difference between a theory and a hypothesis**
  - **A hypothesis is a proposed explanation for a set of observations**
  - **A theory is supported by a large and usually growing body of evidence**

With hypothesis-based science, we pose and test hypotheses

- We solve everyday problems by using hypotheses
  - An example would be the reasoning we use to answer the question, "Why doesn't the flashlight work?"
  - Using deductive reasoning we realize that the problem is either the:

(1) bulb or (2) batteries.

  - The hypothesis must be testable
  - The hypothesis must be falsifiable



The Process of Science

- **Deductive reasoning:**

  Draws specific conclusions based on information (facts)

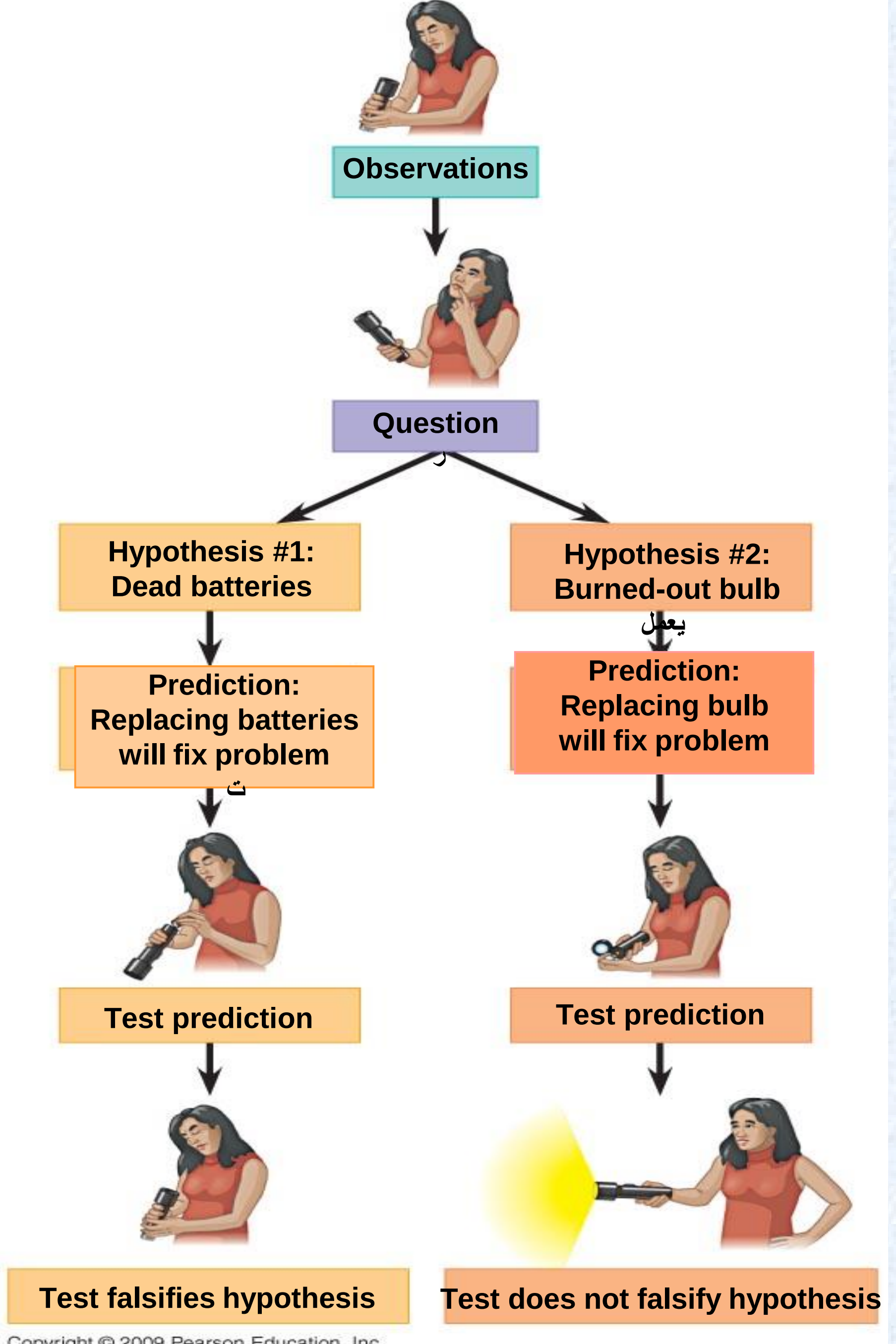
- **Inductive reasoning:**

  Draws general conclusions based on specific (observations)

Steps in the Scientific Method

- **Observation**
- **Question or problem**
- **Hypotheses**
- **Testable predictions**
- **Experiments**
- **Analyze data**
- **Conclusions**

An example of hypothesis-based science



The Hypothesis

- **A tentative (temporary) explanation for observations**
- **Consistent with facts**
- **Can be tested**
- **Tests can be repeated by others**
- **Can be rejected**

Testing Predictions by Experiment

- **Prediction**
- **Deductive product of a hypothesis**
- **Control group**
- **Closely matches experimental group**
- **Experimental group**
- **Differs from control group in 1 variable**

- **Another hypothesis:**

Mimicry helps protect nonpoisonous king snakes from predators where poisonous coral snakes also live

- **The hypothesis predicts that predators learn to avoid the warning coloration of coral snakes**

- Experimentation supports the prediction of the mimicry hypothesis:
- Nonpoisonous snakes that mimic coloration of coral snakes are attacked less frequently
  - The experiment has a control group using brown artificial snakes for comparison
  - The experimental group is artificial snakes with the red, black, and yellow ring pattern of king snakes



Eastern coral snake (poisonous)



Scarlet king snake (nonpoisonous)

Artificial king snake that was not attacked (left); artificial brown snake that was attacked by a bear (right)



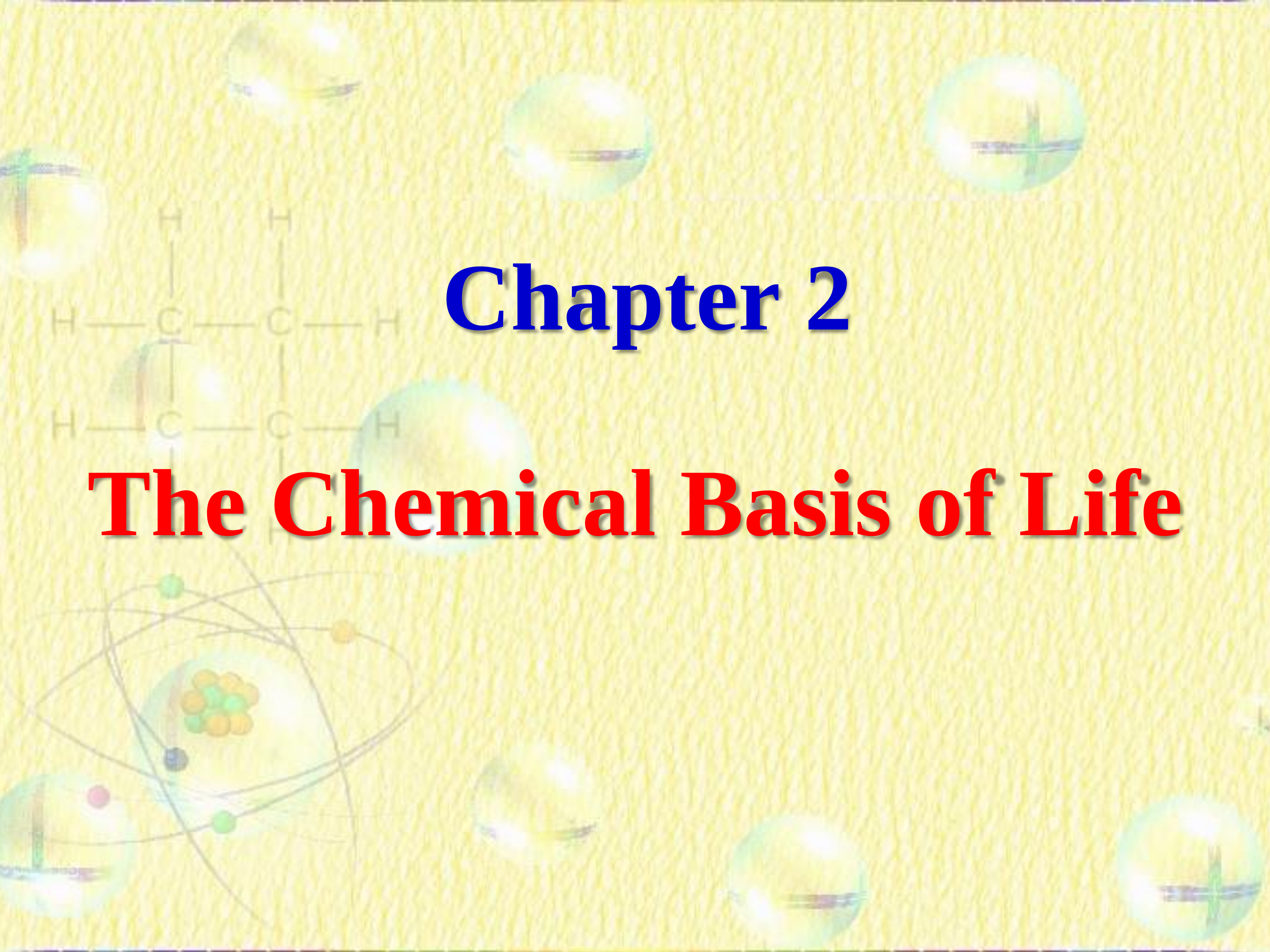


Artificial king snake that was not attacked



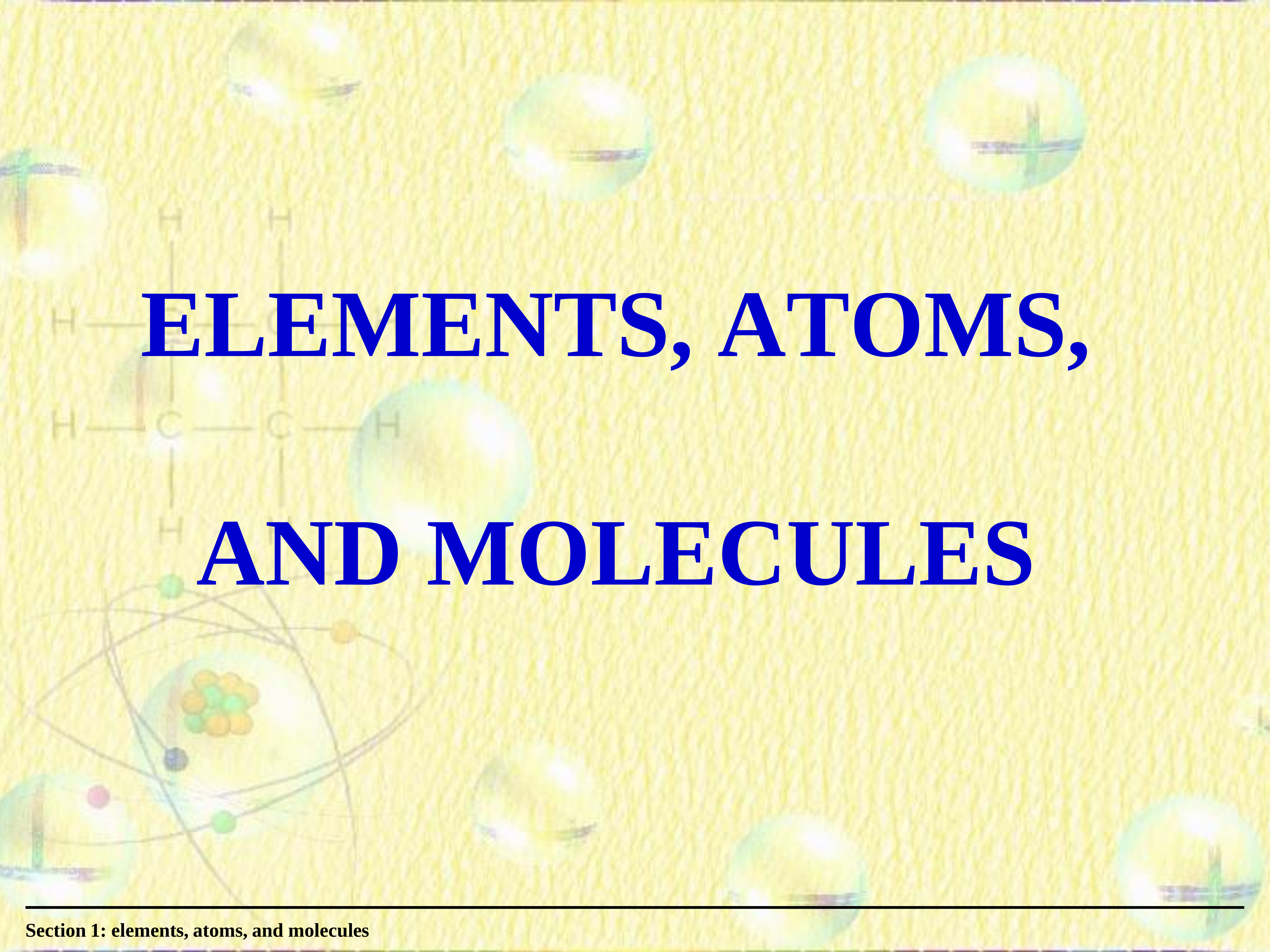
Artificial brown snake that was attacked by a bear




Chapter 2
The Chemical Basis of Life

Introduction

- **Chemicals are the stuff that make up our bodies and those of other organisms.**
- **They make up the physical environment as well.**
- **The ordering of atoms into molecules represents the lowest level of biological organization.**
- **Therefore, to understand life, it is important to understand the basic concepts of chemistry.**


ELEMENTS, ATOMS,
AND MOLECULES

Living organisms are composed of about 25 chemical elements

- **Chemicals are at the base level of biological hierarchy .**
- **They are arranged into higher and higher levels of structural organization.**
- **Arrangement eventually leads to formation of living organisms.**

Living organisms are composed of about 25 chemical elements

- **Living organisms are composed of matter, which is anything that occupies space and has mass (weight)**
  - **Matter is composed of chemical elements .**
  - **Element — a substance that cannot be broken down to other substance.**
  - **There are 92 elements in nature — only a few exist in a pure state.**
  - **Life requires 25 essential elements; some are called trace elements.**

TABLE 2.1 ELEMENTS IN THE HUMAN BODY

Element	Symbol	Percentage of Human Body Weight	
Oxygen	O	65.0	96.3 (O, C, H, N combined)
Carbon	C	18.5	
Hydrogen	H	9.56	
Nitrogen	N	3.3	
Calcium	Ca	1.5	
Phosphorus	P	1.0	
Potassium	K	0.4	
Sulfur	S	0.3	
Sodium	Na	0.2	
Chlorine	Cl	0.2	
Magnesium	Mg	0.1	

Trace elements (less than 0.01%): boron (B), chromium (Cr), cobalt (Co), copper (Cu), fluorine (F), iodine (I), iron (Fe), manganese (Mn), molybdenum (Mo), selenium (Se), silicon (Si), tin (Sn), vanadium (V), and zinc (Zn).

Elements in the Human Body

Essential Elements

S H O P C N

Invariably found in all living organisms

Variable Elements

Na K Ca Mg Fe Cl

Variably found in living organisms

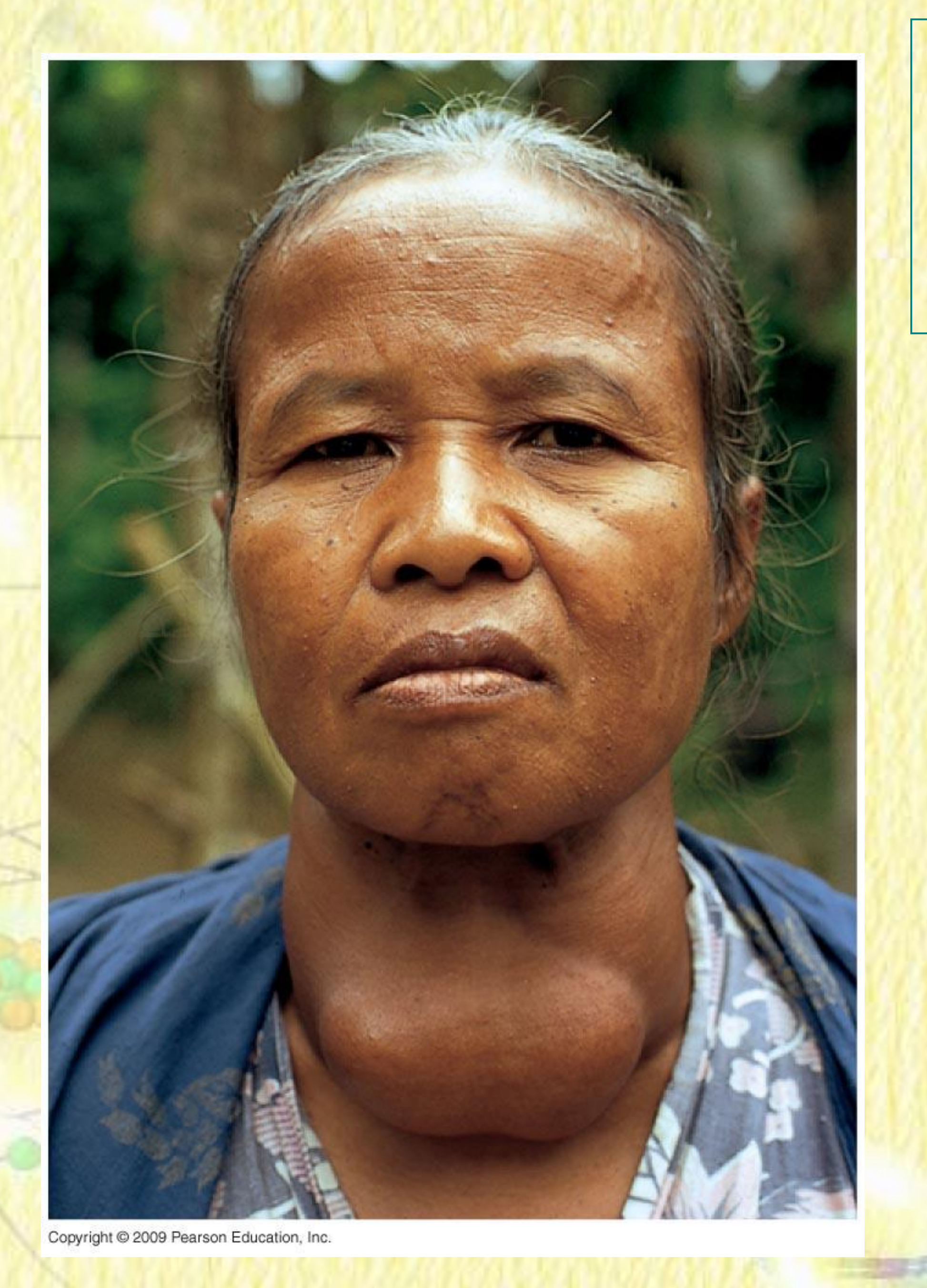
Trace Elements

Cu Zn Mn Se Si F I

Found in trace amounts in some, but not all, organisms

CONNECTION: Trace elements are common additives to food and water

- **Some trace elements are required to prevent disease**
  - **Without iron, your body cannot transport oxygen**
  - **An iodine deficiency prevents production of thyroid hormones, resulting in goiter**



Goiter in a Malaysian woman, a symptom of iodine deficiency

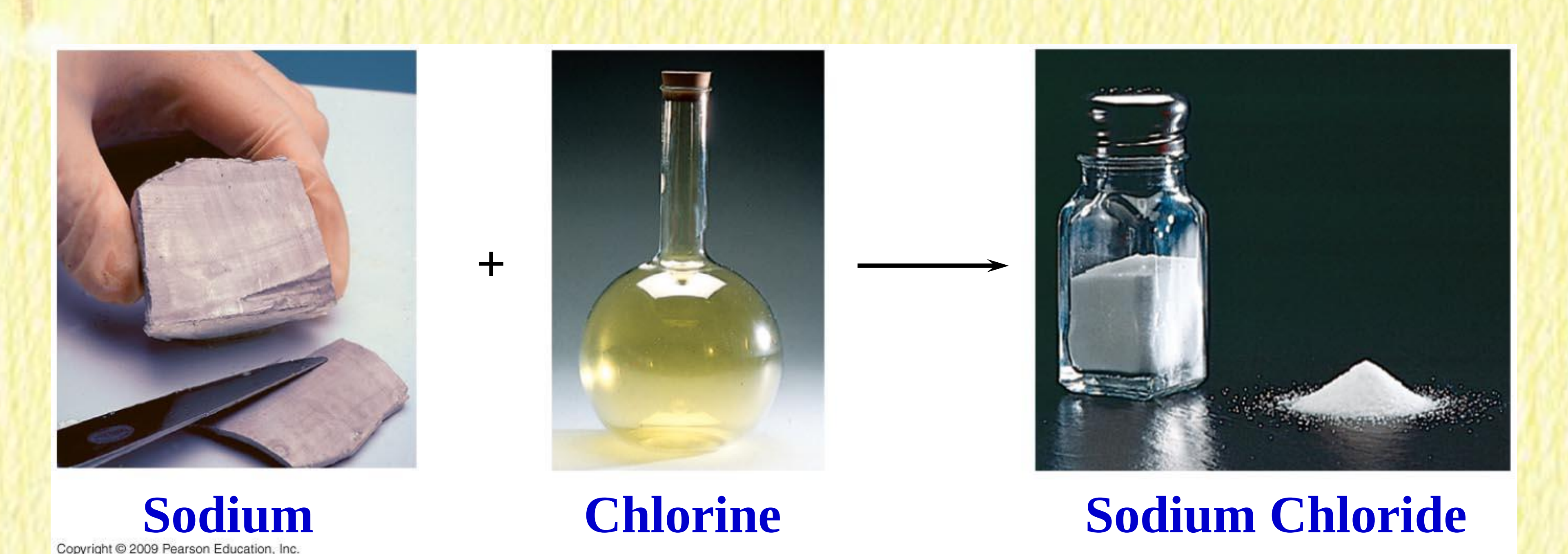
CONNECTION: Trace elements are common additives to food and water

- **Several chemicals are added to food for a variety of reasons**
  - **Help preserve it**
  - **Make it more nutritious**
  - **Make it look better**
- **Check out the "Nutrition Facts" label on foods and drinks you purchase**

Elements can combine to form compounds

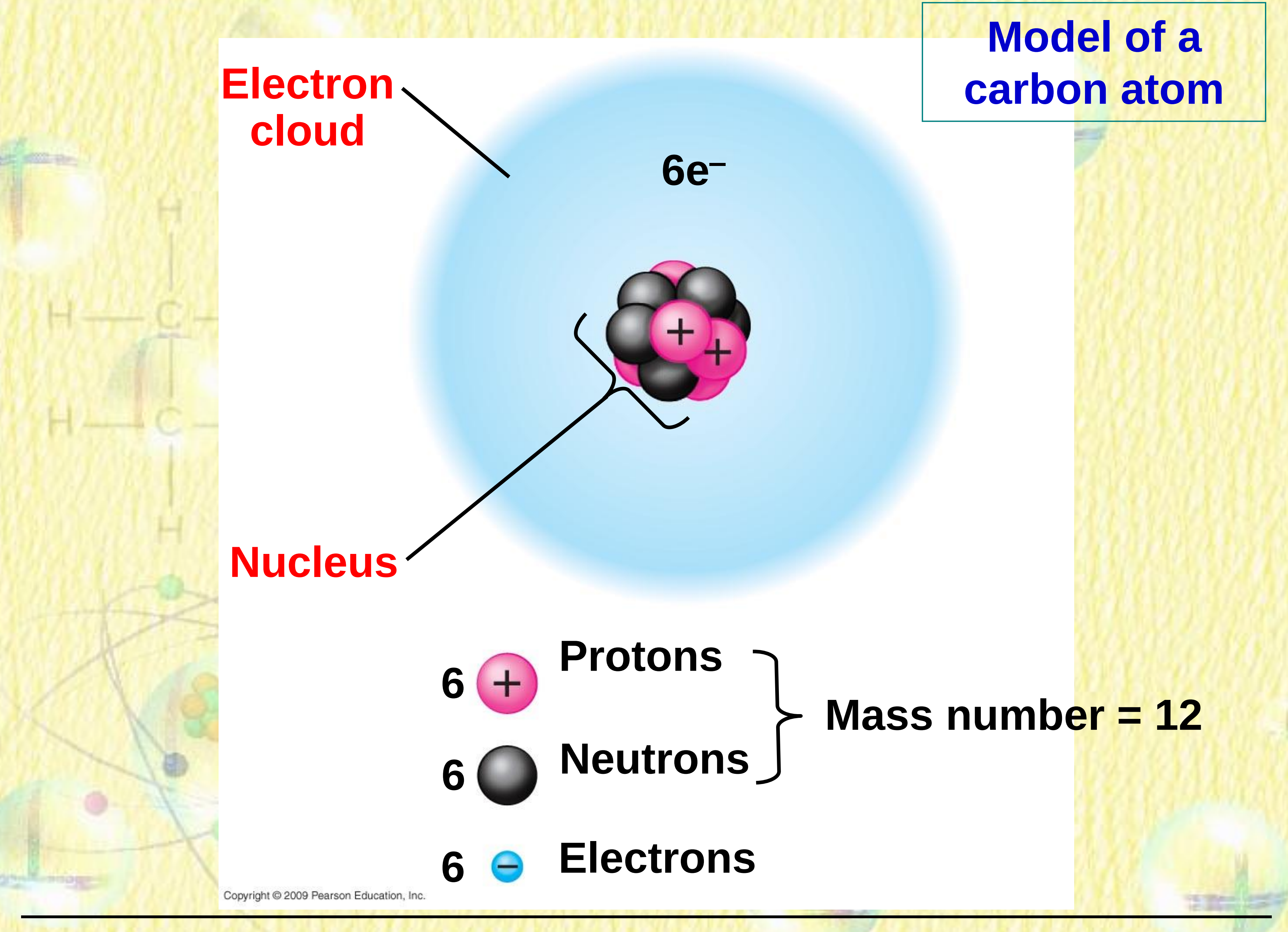
- **Compound - a substance consisting of two or more different elements combined in a fixed ratio.**
  - **There are many compounds that consist of only two elements.**
    - **Table salt (sodium chloride or NaCl) is an example.**
    - **Sodium is a metal, and chloride is a poisonous gas.**
    - **However, when chemically combined, an edible compound emerges.**

The emergent properties of the edible compound sodium chloride



Atoms consist of protons, neutrons, and electrons

- An atom is the smallest unit of matter that still retains the properties of an element
- Atoms are made of over a hundred subatomic particles, but only three are important for biological compounds
  - Proton — has a single positive electrical charge
  - Electron — has a single negative electrical charge
  - Neutron — is electrically neutral


Model of a carbon atom
Electron cloud
6e⁻
Nucleus
6 Protons
6 Neutrons
Mass number = 12
6 Electrons
Copyright © 2009 Pearson Education, Inc.

Atoms consist of protons, neutrons, and electrons

- **Although all atoms of an element have the same atomic number, some differ in mass number**
  - **The variations are isotopes, which have the same numbers of protons and electrons but different numbers of neutrons**
    - **One isotope of carbon has 8 neutrons instead of 6 (written ^{14}C)**
    - **Unlike ^{12}C, ^{14}C is an unstable (radioactive) isotope that gives off energy**

TABLE 2.4 ISOTOPES OF CARBON

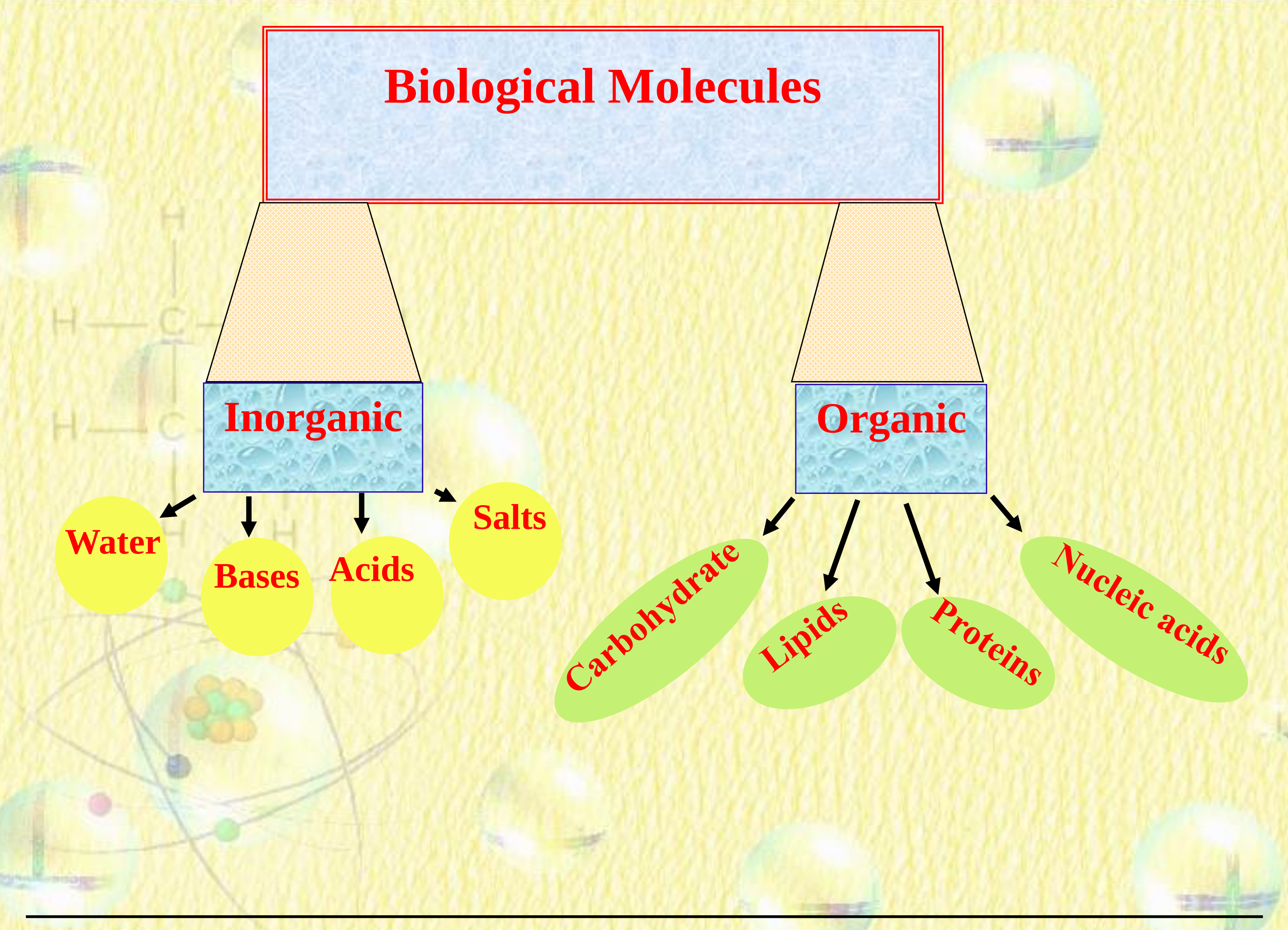
	Carbon-12	Carbon-13	Carbon-14
Protons	6	6	6
Neutrons	6	7	8
Electrons	6	6	6

CONNECTION: Radioactive isotopes can help or harm us

- **Living cells cannot distinguish between isotopes of the same element.**
  - **Therefore, when radioactive compounds are used in metabolic processes, they act as tracers.**
  - **Radioactivity can be detected by instruments.**
- **With instruments, the fate of radioactive tracers can be monitored in living organisms.**
- **Radioactive tracers are frequently used in medical diagnosis.**
- **Sophisticated (advanced) imaging instruments are used to detect them.**

2.5 CONNECTION: Radioactive isotopes can help or harm us

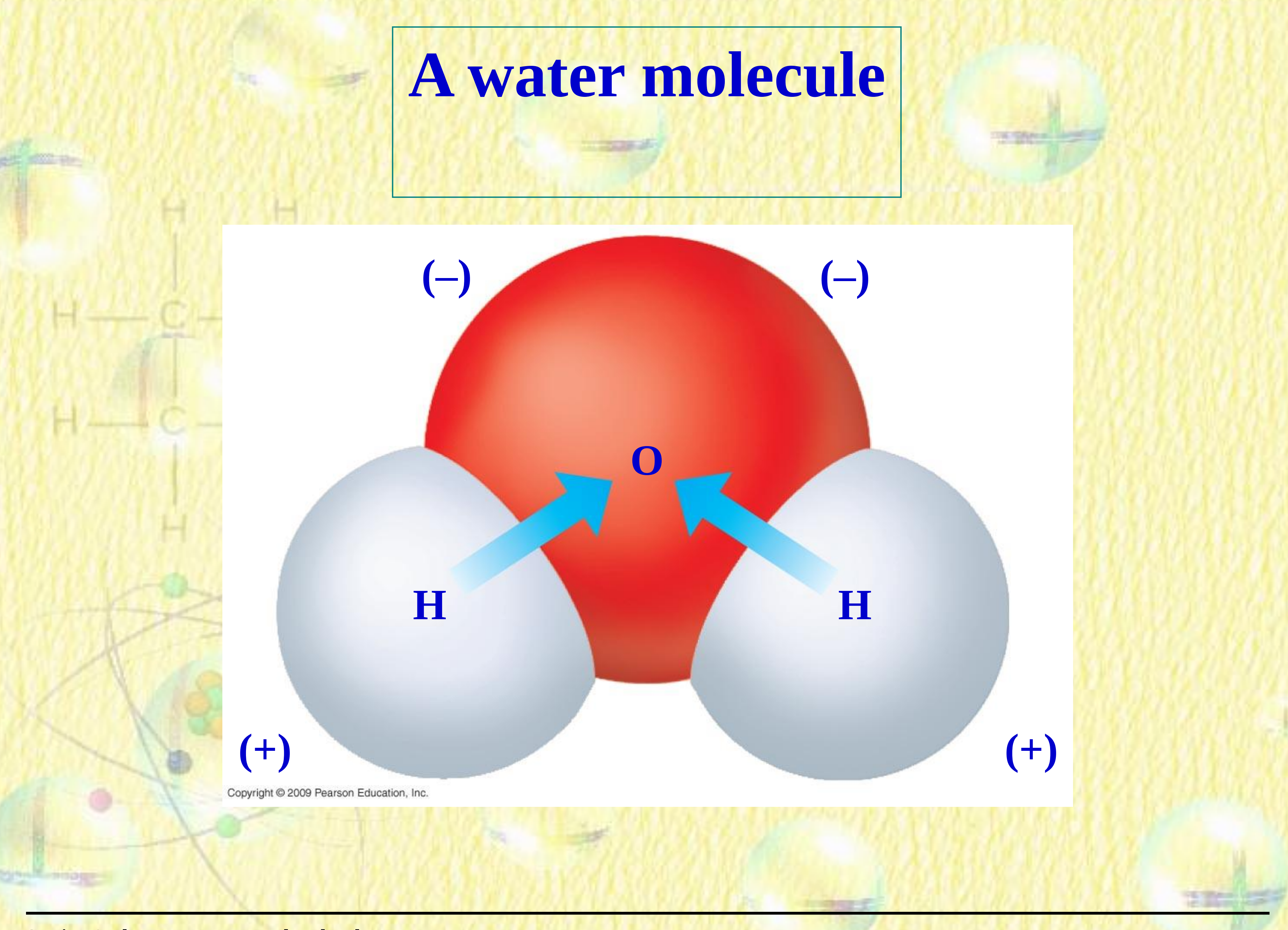
- **In addition to benefits, there are also dangers associated with using radioactive substances**
  - **Uncontrolled exposure can cause damage to some molecules in a living cell, especially DNA**
  - **Chemical bonds are broken by the emitted energy.**


Biological Molecules
Inorganic
Organic
Water
Bases
Acids
Salts
Carbohydrate
Lipids
Proteins
Nucleic acids

Water properties

- **Water has atoms with different electronegativities**
  - **Oxygen attracts the shared electrons more strongly than hydrogen**
  - **So, the shared electrons spend more time near oxygen**
  - **The result is a polar covalent bond**

A water molecule

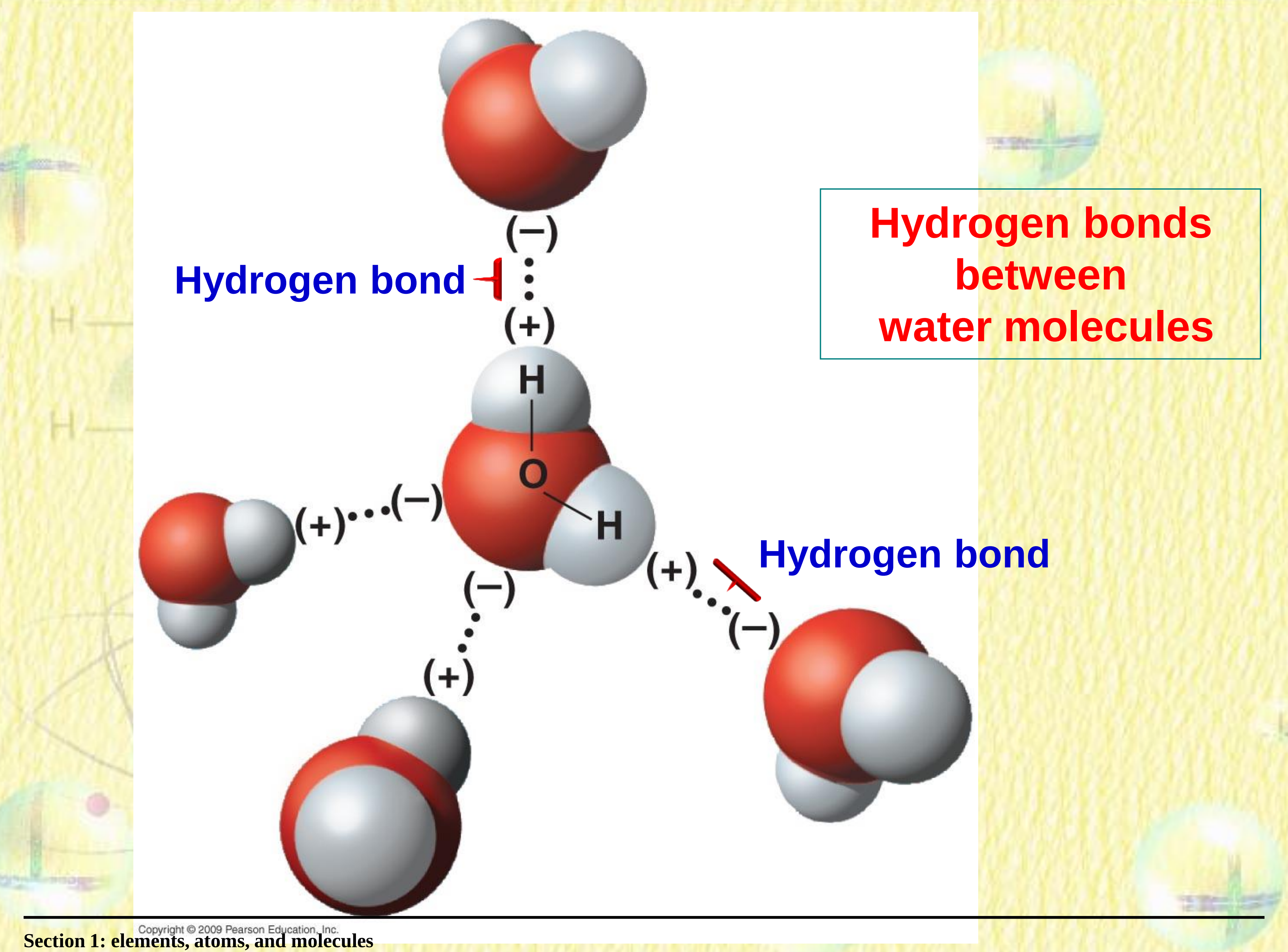


Water is Polar

- In each water molecule, the **oxygen atom attracts more** than its "fair share" of **electrons**
- The **oxygen** end “acts” **negative**
- The **hydrogen** end “acts” **positive**
- Causes the water to be **POLAR**
- However, Water is **neutral** (equal number of e- and p+) --- **Zero Net Charge**

Hydrogen bonds are weak bonds important in the chemistry of life

- **Hydrogen, as part of a polar covalent bond, will share attractions with other electronegative atoms**
  - **Examples are oxygen and nitrogen**
- **Water molecules are electrically attracted to oppositely charged regions on neighboring molecules**
  - **Because the positively charged region is always a hydrogen atom, the bond is called a Hydrogen bond**


Hydrogen bonds
between
water molecules
Hydrogen bond
(–)
(+)
H
O
H
(+)
(–)
(–)
(+)
(+)
(–)
Hydrogen bond


WATER'S LIFE-SUPPORTING
PROPERTIES
Section 1: elements, atoms, and molecules

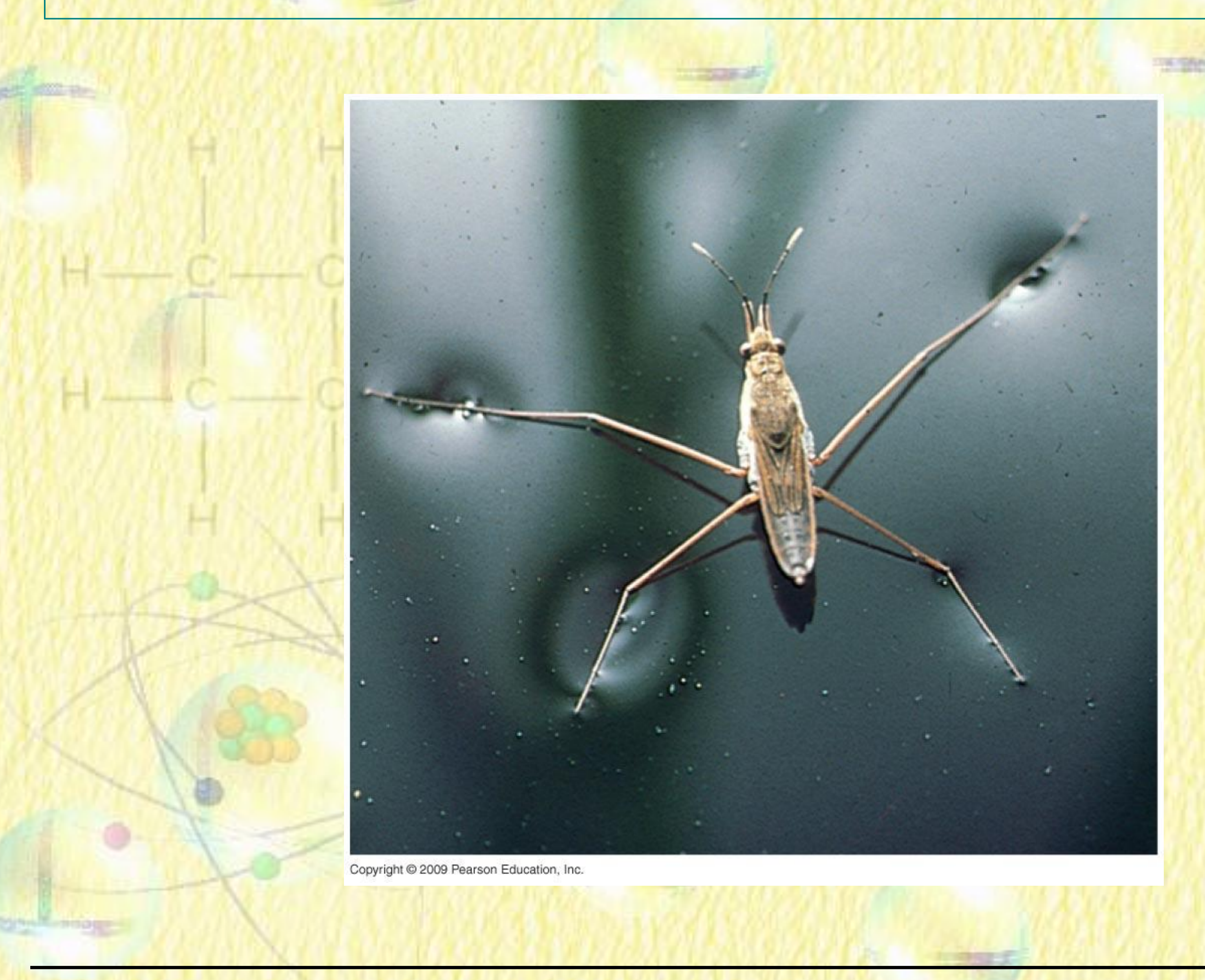
Hydrogen bonds make liquid water cohesive

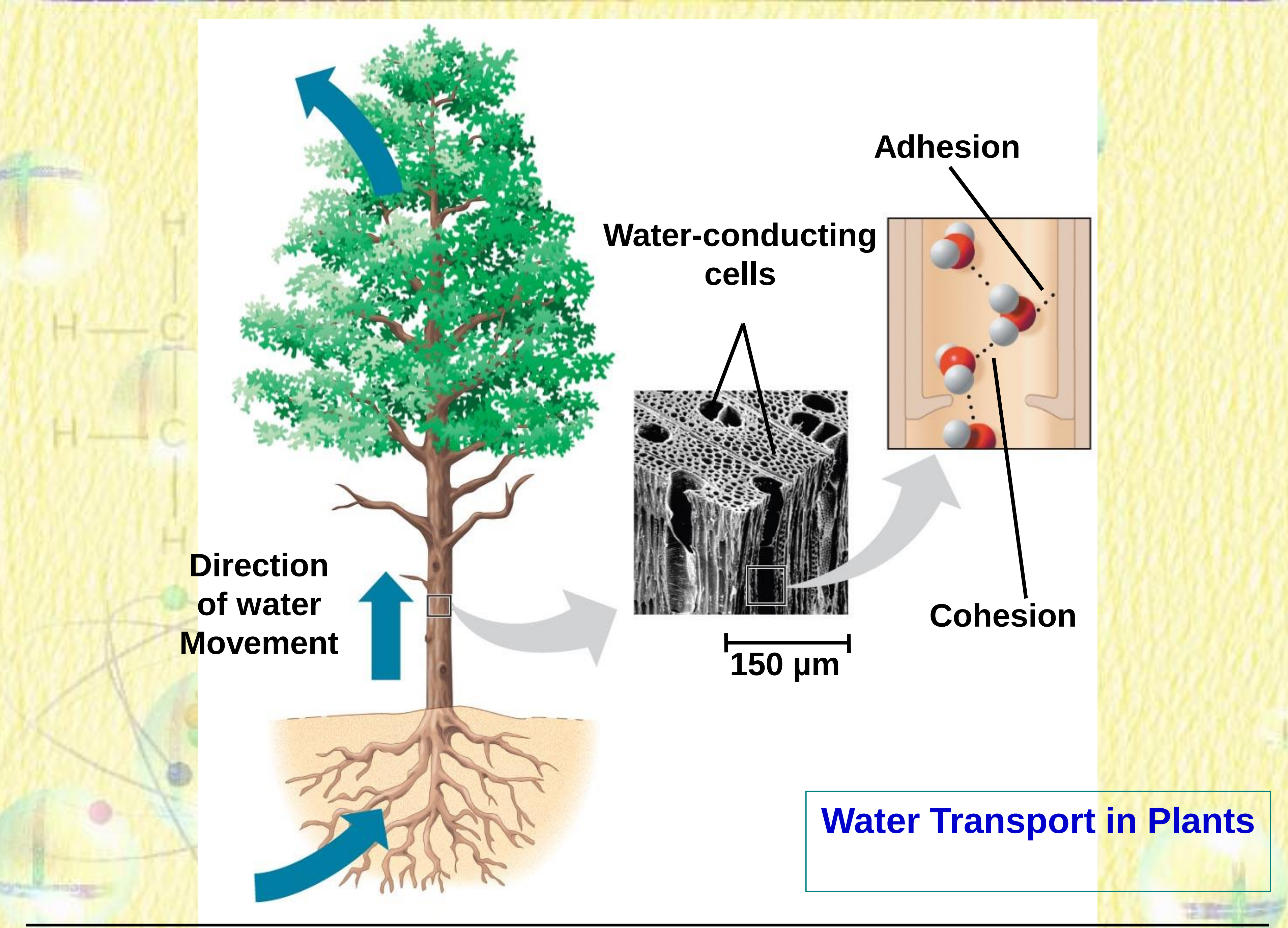
- **Hydrogen bonding causes molecules to stick together, a property called cohesion**
  - **Cohesion is much stronger for water than other liquids.**
  - **This is useful in plants that depend upon cohesion to help transport water and nutrients up the plant.**

Hydrogen bonds make liquid water cohesive

- **Cohesion is related to surface tension — a measure of how difficult it is to break the surface of a liquid**
  - **Hydrogen bonds are responsible for surface tension**

Surface tension allows a water strider to walk on water




Adhesion
Water-conducting
cells
Direction
of water
Movement
150 µm
Cohesion
Water Transport in Plants

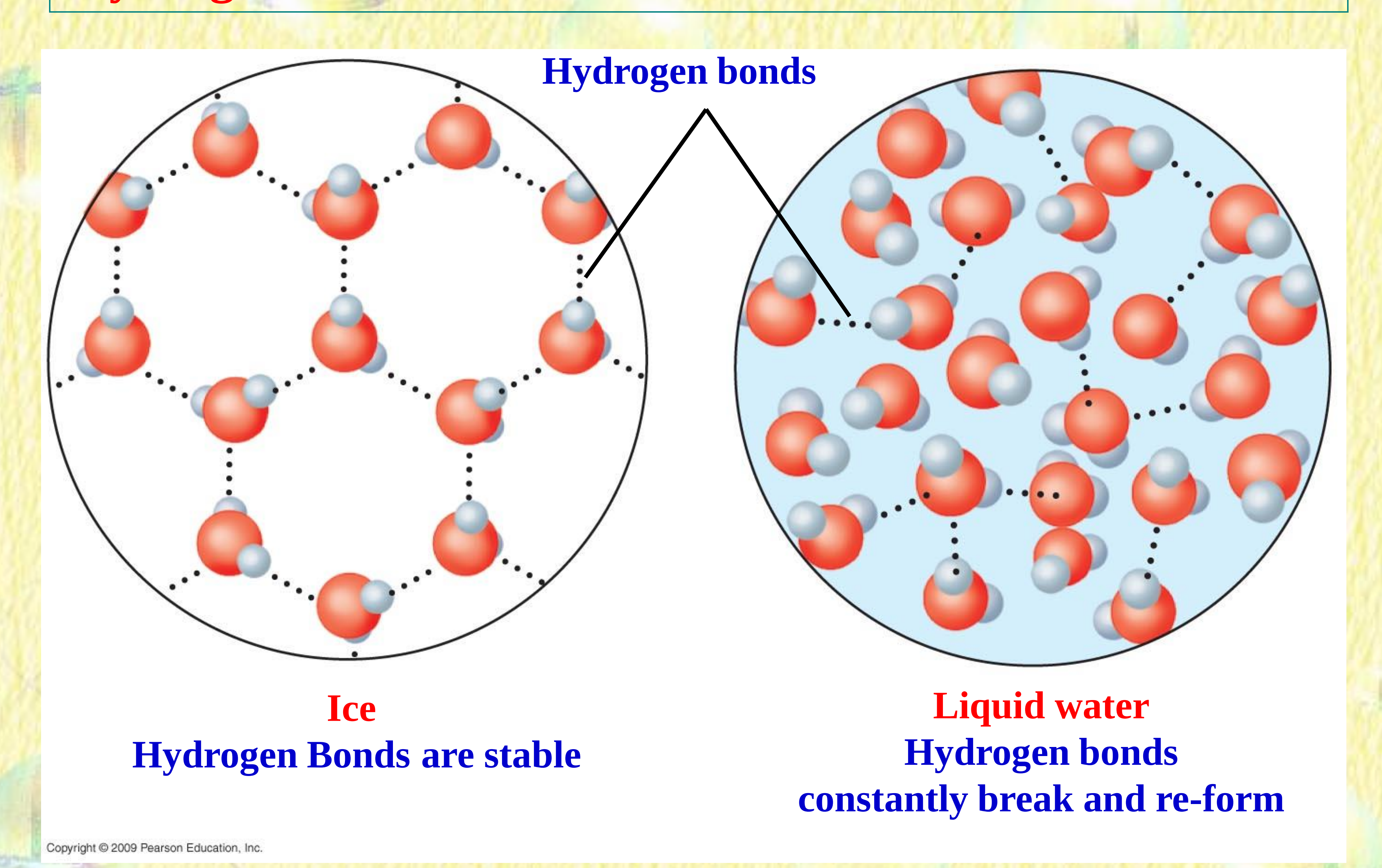
Ice is less dense than liquid water

- Water can exist as a gas, liquid, and solid
  - Water is less dense as a solid, a property due to hydrogen bonding

Ice is less dense than liquid water

- **When water freezes, each molecule forms a stable hydrogen bond with four neighbors**
  - **A three-dimensional crystal results**
  - **There is space between the water molecules**
- **Ice is less dense than water, so it floats**

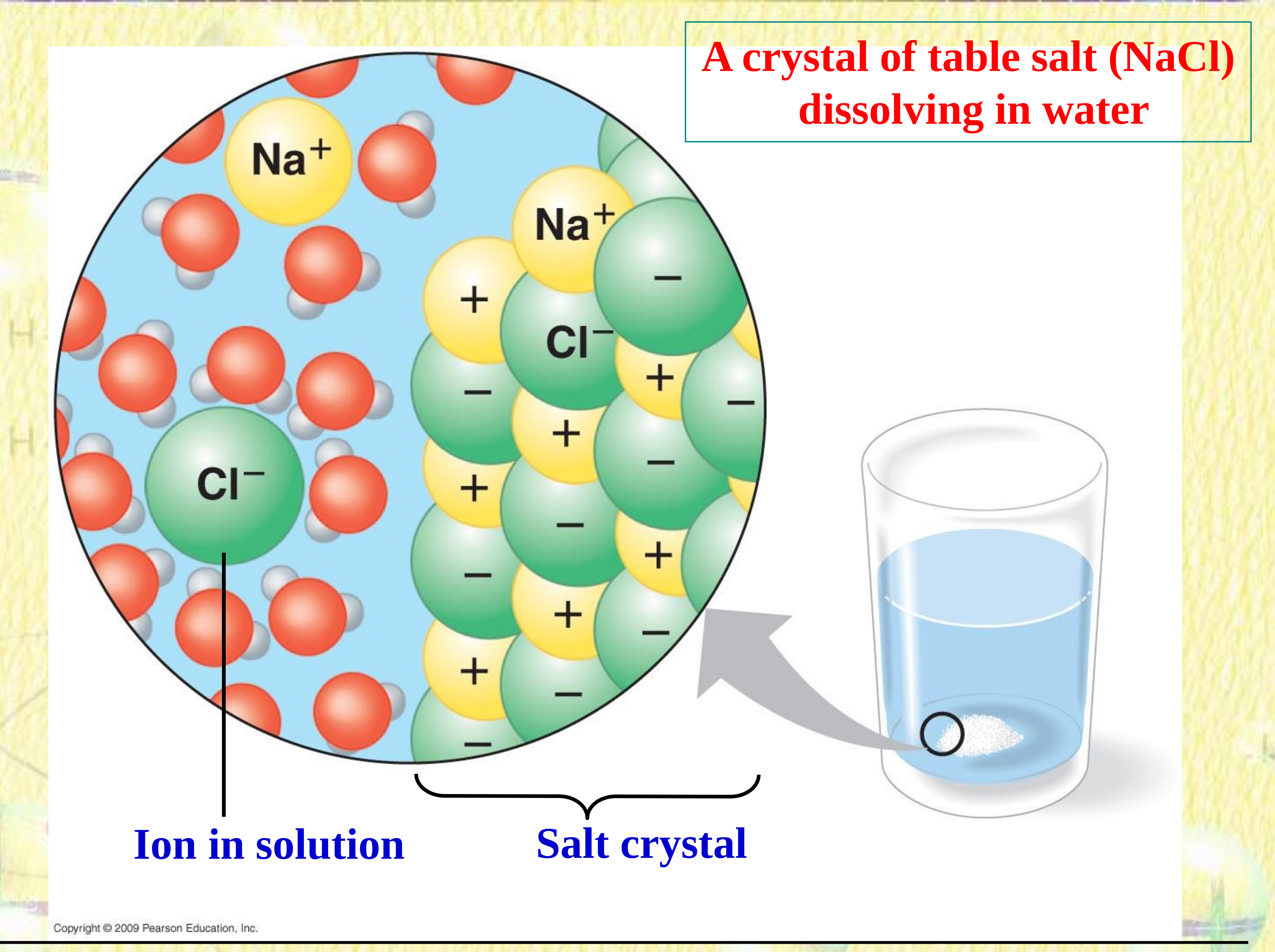
Hydrogen bonds between water molecules in ice and water



Water is the solvent of life

- **Water is a versatile solvent that is fundamental to life processes**
  - **Its versatility results from its polarity**
  - **Table salt is an example of a solute that will go into solution in water**
    - **Sodium and chloride ions and water are attracted to each other because of their charges**

A crystal of table salt (NaCl) dissolving in water



Properties of Water

- Cohesion-Attraction between particles of the same substance.

- Adhesion-Attraction between two different substances.

- Water will make hydrogen bonds with other surfaces such as glass, soil, plant tissues, and cotton.

- Less Dense as a Solid

Acidic and basic conditions

- A few water molecules can break apart into ions
  - Some are hydrogen ions (H^+).
  - Some are hydroxide ions (OH^-) .
    - Both are extremely reactive.
    - A balance between the two is critical for chemical processes to occur in a living organism.

Acidic and basic conditions

- **Chemicals other than water can contribute H^+ to a solution**
  - **They are called acids**
  - **An example is hydrochloric acid (HCl)**
    - **This is the acid in your stomach that aids in digestion**
- **An acidic solution has a higher concentration of H^+ than OH^-**

Acidic and basic conditions

- **A pH scale (pH = potential of hydrogen) is used to describe whether a solution is acidic or basic**
  - **pH ranges from 0 (most acidic) to 14 (most basic)**
  - **A solution that is neither acidic or basic is neutral (pH = 7)**

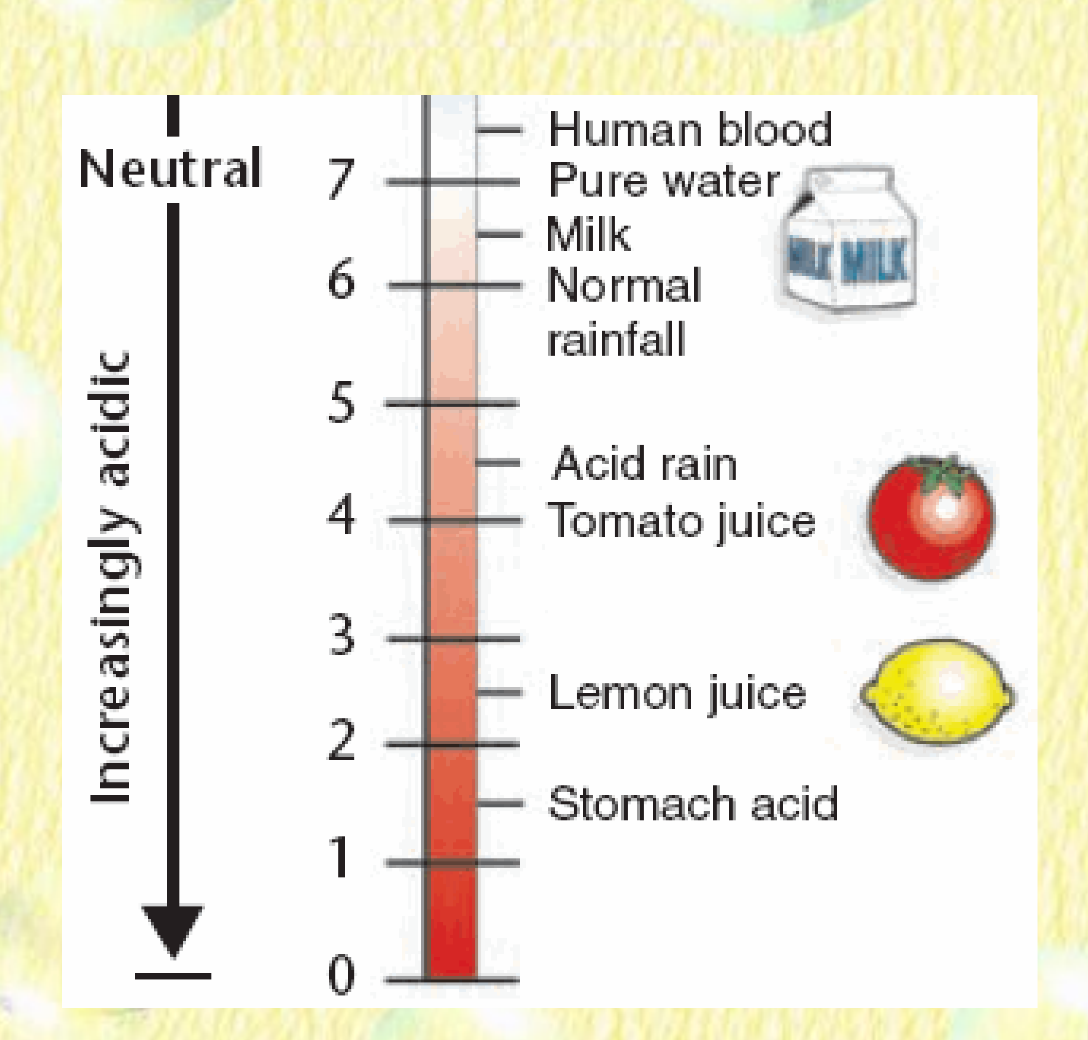
The pH Scale

- **Indicates the concentration of H^+ ions**
- **Ranges from 0 – 14**
- **pH of 7 is neutral**
- **pH 0 up to 7 is acid … H^+**
- **pH above 7 – 14 is basic… OH^-**

Acids

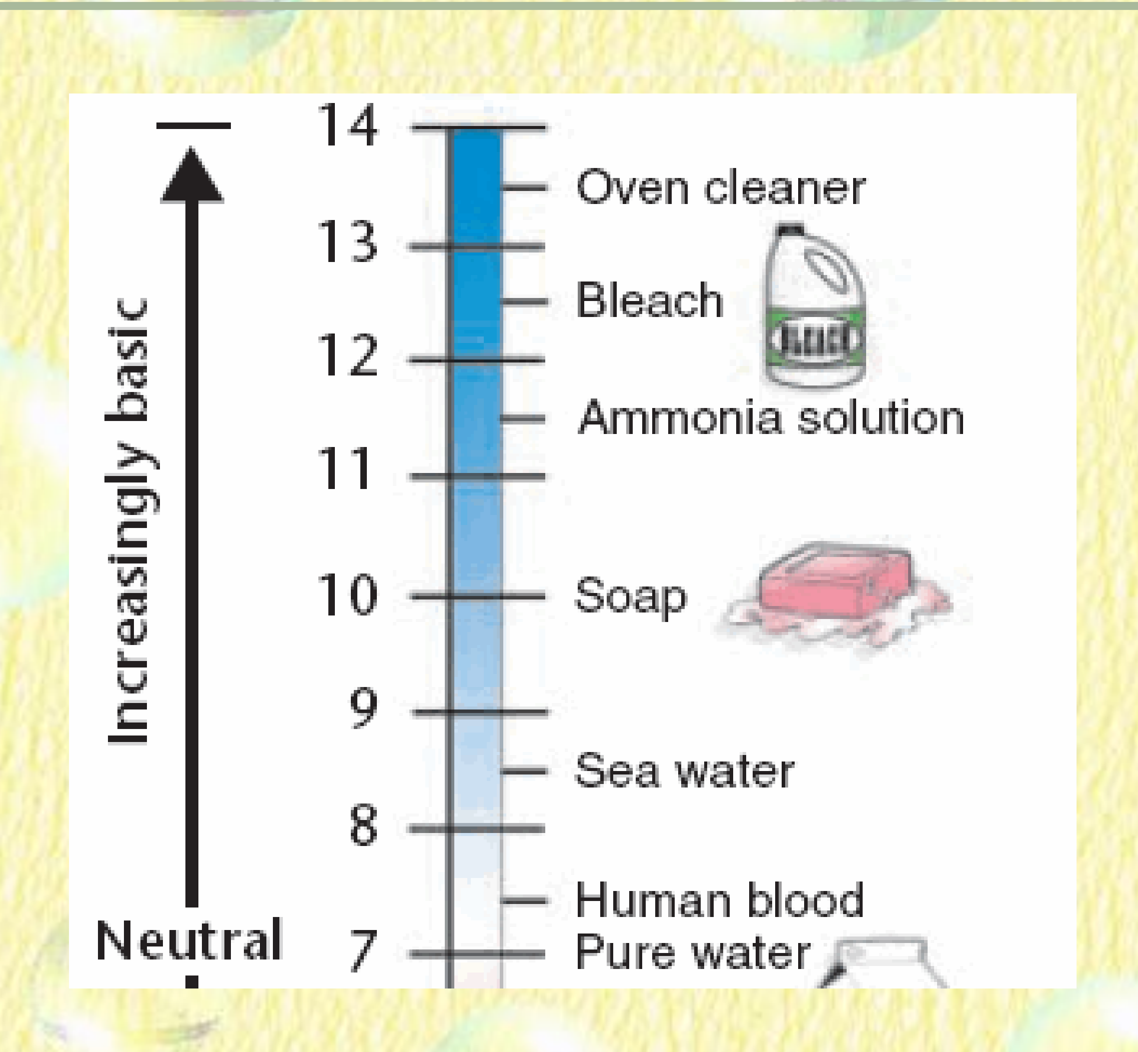
- **Strong Acids have a pH of 1-3**

- **Produce lots of H^+ ions**



Bases

- **Strong Bases have a pH of 11 to 14**
- **Contain lots of OH^- ions and fewer H+ ions**



Buffers

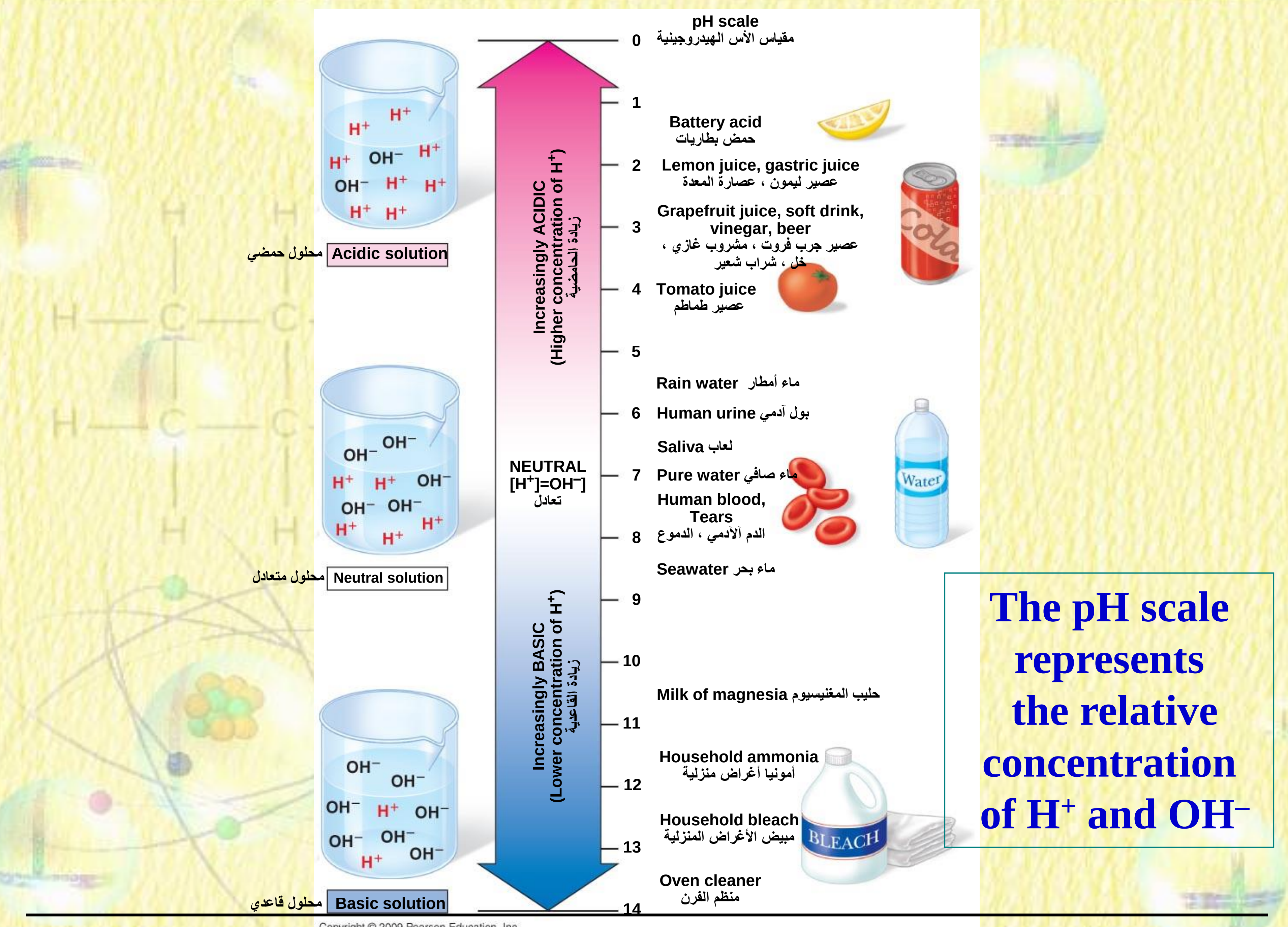
- **Weak acids or bases that react with strong acids or bases to prevent sharp, sudden changes in pH (neutralization).**
- **Produced naturally by the body to maintain homeostasis**



Weak Acid



Weak Base



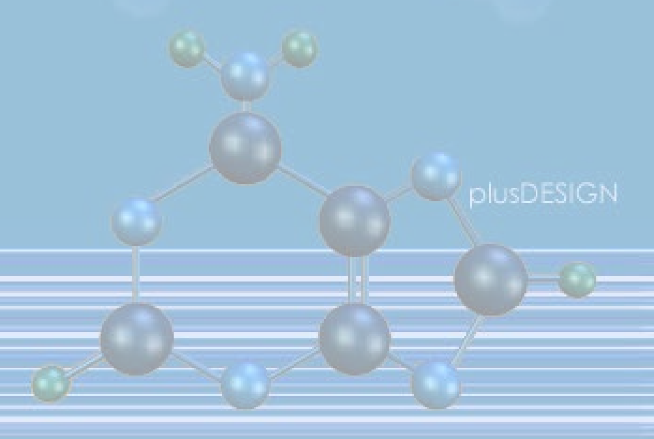
pH scale
مقياس الأس الهيدروجينية
0
1
Battery acid
حمض بطاريات
2
Lemon juice, gastric juice
عصير ليمون ، عصارة المعدة
3
Grapefruit juice, soft drink, vinegar, beer
عصير جرب فروت ، مشروب غازي ، خل ، شراب شعير
4
Tomato juice
عصير طماطم
5
Rain water ماء أمطار
6
Human urine بول آدمي
Saliva لعاب
7
Pure water ماء صافي
Human blood, Tears
الدم الآدمي ، الدموع
8
Seawater ماء بحر
9
10
Milk of magnesia حليب المغنيسيوم
11
Household ammonia
أمونيا أغراض منزلية
12
Household bleach
مبيض الأغراض المنزلية
13
Oven cleaner
منظم الفرن
14
Increasingly ACIDIC
(Higher concentration of H+)
زيادة الحامضية
NEUTRAL
[H+]=OH−]
تعادل
Increasingly BASIC
(Lower concentration of H+)
زيادة القاعدية
Acidic solution محلول حمضي
Neutral solution محلول متعادل
Basic solution محلول قاعدي
Cola
Water
BLEACH
Copyright © 2009 Pearson Education, Inc.
The pH scale represents the relative concentration of H+ and OH–

CONNECTION: Acid precipitation and ocean acidification threaten the environment

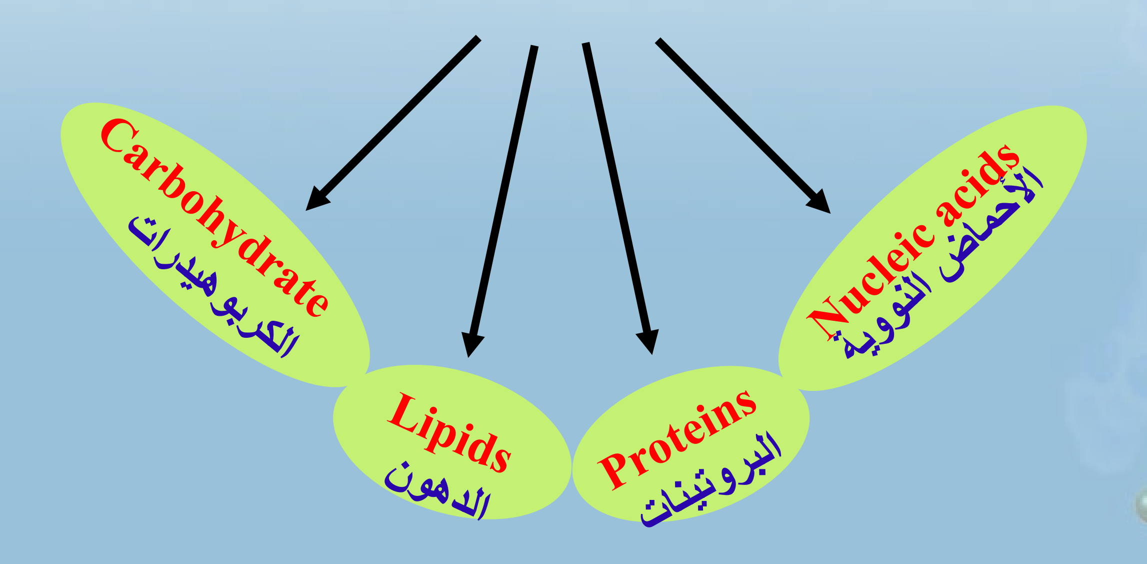
- **When we burn fossil fuels (gasoline and heating oil), air-polluting compounds and CO_2 are released into the atmosphere**
  - **Sulfur and nitrous oxides react with water in the air to form acids**
    - **These fall to Earth as acid precipitation, which is rain, snow, or fog with a pH lower than 5.6**
  - **Additional CO_2 in the atmosphere contributes to the "greenhouse" effect and alters ocean chemistry.**

Chapter 3
The Molecules of Cells





INTRODUCTION TO ORGANIC COMPOUNDS (Molecules)



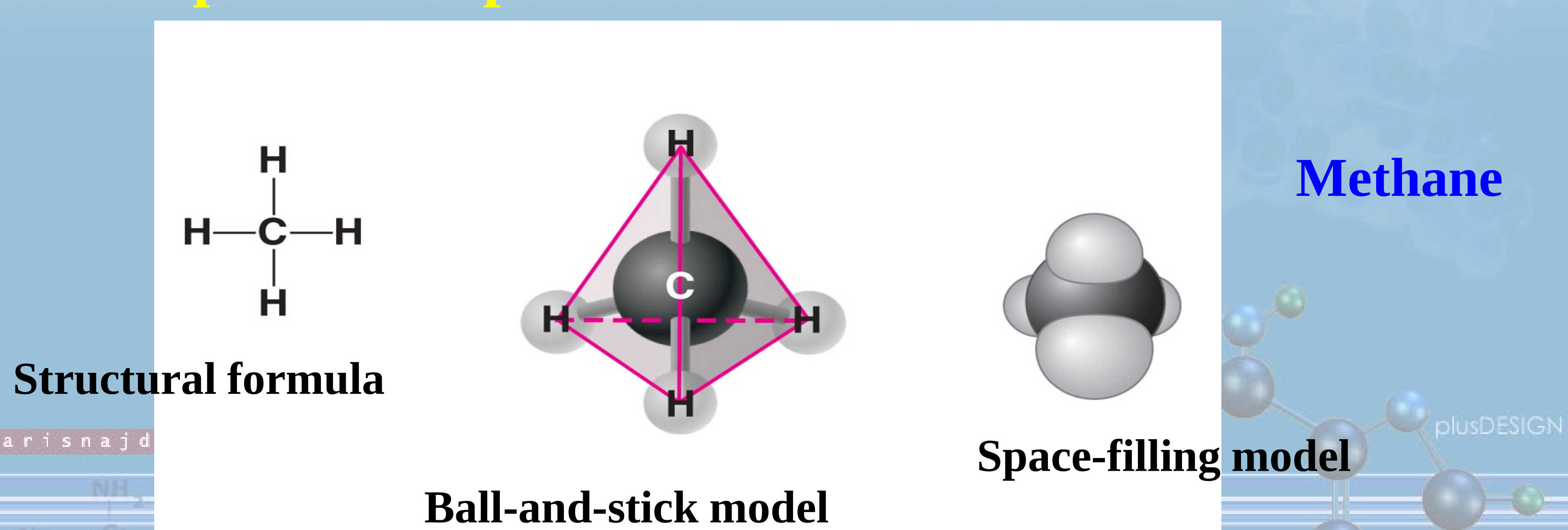
ORGANIC COMPOUNDS (Molecules)

3.1 Life's molecular diversity is based on the properties of carbon

- Diverse molecules found in cells are composed of carbon bonded to other elements
- Carbon-based molecules are called Organic Compounds
- By sharing electrons, carbon can bond to four other atoms
- By doing so, carbon can branch in up to four directions



- **Methane (CH_4) is one of the simplest organic compounds**
  - **Four covalent bonds link four hydrogen atoms to the carbon atom**
  - **Each of the four lines in the formula for Methane represents a pair of shared electrons**



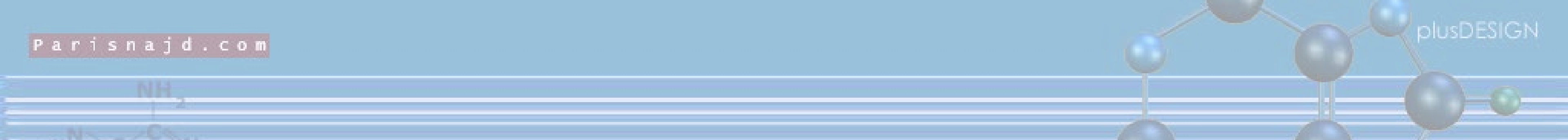
The four single bonds of carbon point to the corners of a tetrahedron.

ORGANIC COMPOUNDS (Molecules)

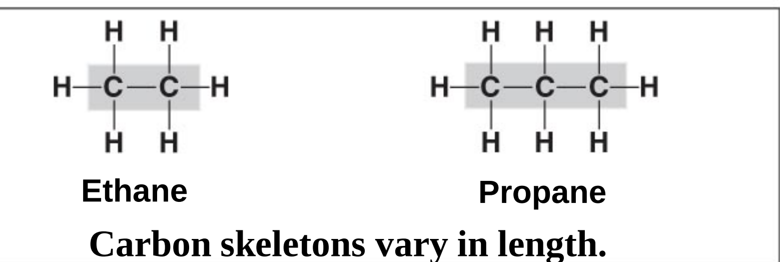
- **Methane and other compounds composed of only carbon and hydrogen are called hydrocarbons**
- **Carbon atoms, with attached hydrogens, can bond together in chains of various lengths**

3.1 Life's molecular diversity is based on the properties of carbon

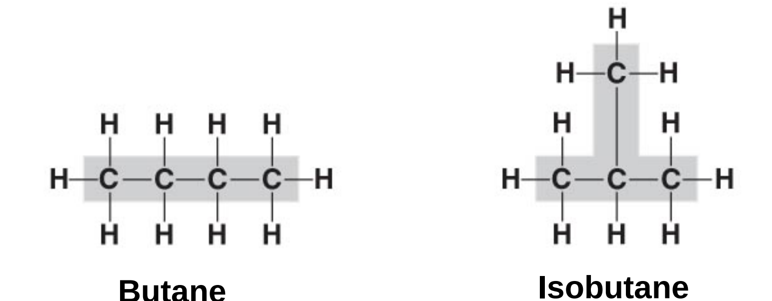
- **A chain of carbon atoms is called a carbon skeleton**
- **Carbon skeletons can be branched or unbranched**
- **Therefore, different compounds with the same molecular formula can be produced**
- **These structures are called ISOMERS**



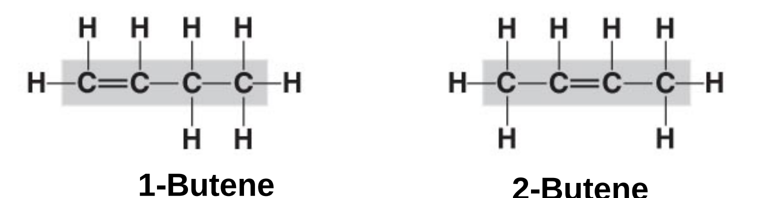
Variations in carbon skeletons
التنوع في الهياكل الكربونية



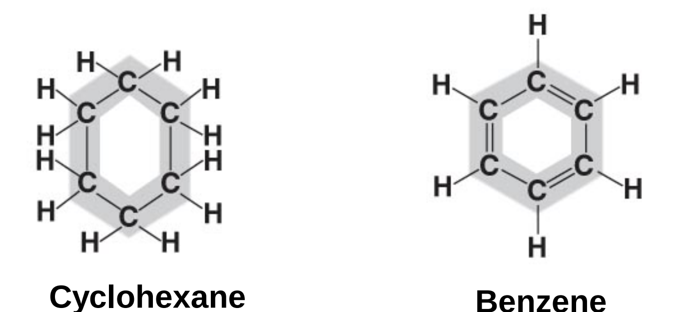
Carbon skeletons vary in length.



Branching. Skeletons may be unbranched or branched.



Skeletons may have double bonds, which can vary in location.



Skeletons may be arranged in rings.

3.2 Characteristic chemical groups help determine the properties of organic compounds

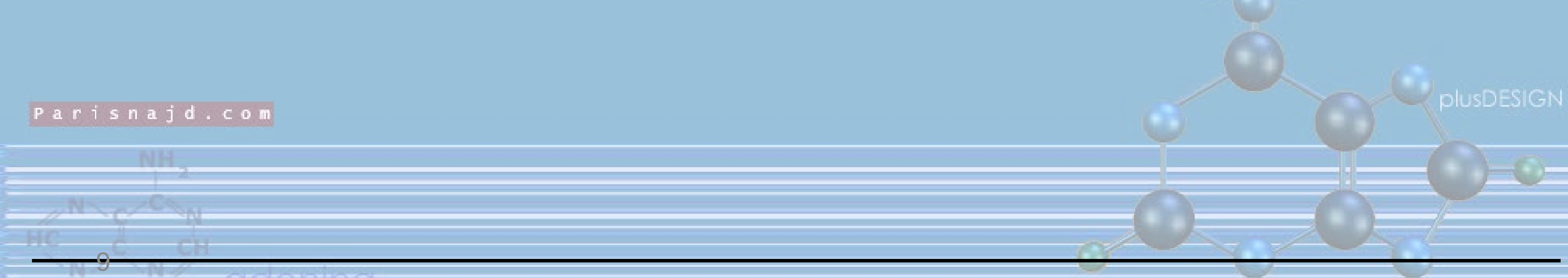
- **An organic compound has unique properties that depend upon**
  1. **The size and shape of the molecule, and**
  2. **The groups of atoms (functional groups) attached to it.**

- **A functional group affects a biological molecule's function in a characteristic way**



3.2 Characteristic chemical groups help determine the properties of organic compounds

- Compounds containing functional groups are **hydrophilic** (water-loving)
- This means that they are soluble in water, which is a necessary prerequisite for their roles in water-based life



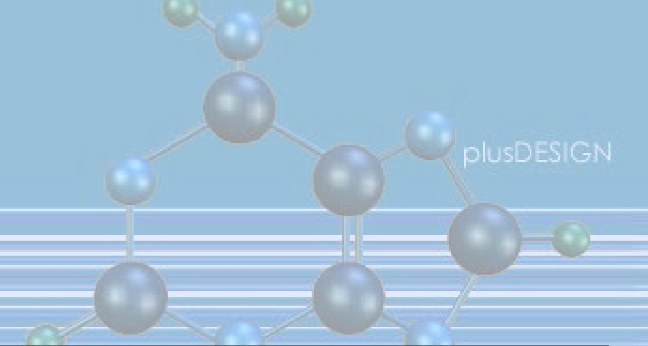
3.2 Characteristic chemical groups help determine the properties of organic compounds

- **The functional groups are**

  - **Hydroxyl group — consists of a hydrogen bonded to an oxygen**
  - **Carbonyl group — a carbon linked by a double bond to an oxygen atom**
  - **Carboxyl group — consists of a carbon bonded to a hydroxyl group and double-bonded to an oxygen**
  - **Amino group — composed of a nitrogen bonded to two hydrogen atoms and a carbon skeleton**
  - **Phosphate group — consists of a phosphorus atom bonded to four oxygen atoms**

3.3 Cells make a huge number of large molecules from a small set of small molecules

- There are four classes of biological molecules
  1. Carbohydrates
  2. Proteins
  3. Lipids
  4. Nucleic acids



ORGANIC COMPOUNDS (Molecules)

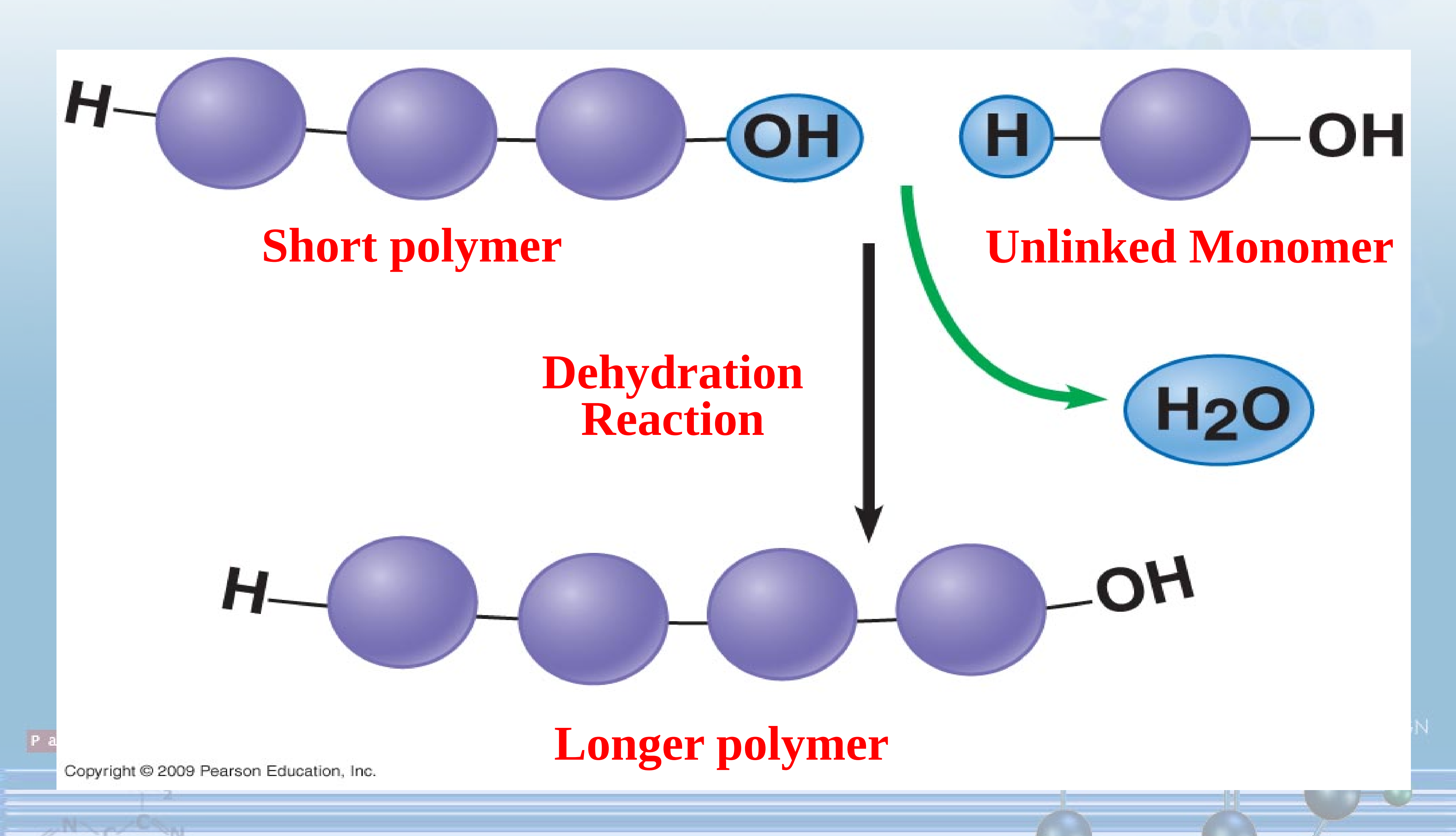
- **The four classes of biological molecules contain very large molecules**
  - **They are often called macromolecules because of their large size**
  - **They are also called polymers because they are made from identical building blocks strung together**
  - **The building blocks are called monomers**

ORGANIC COMPOUNDS (Molecules)

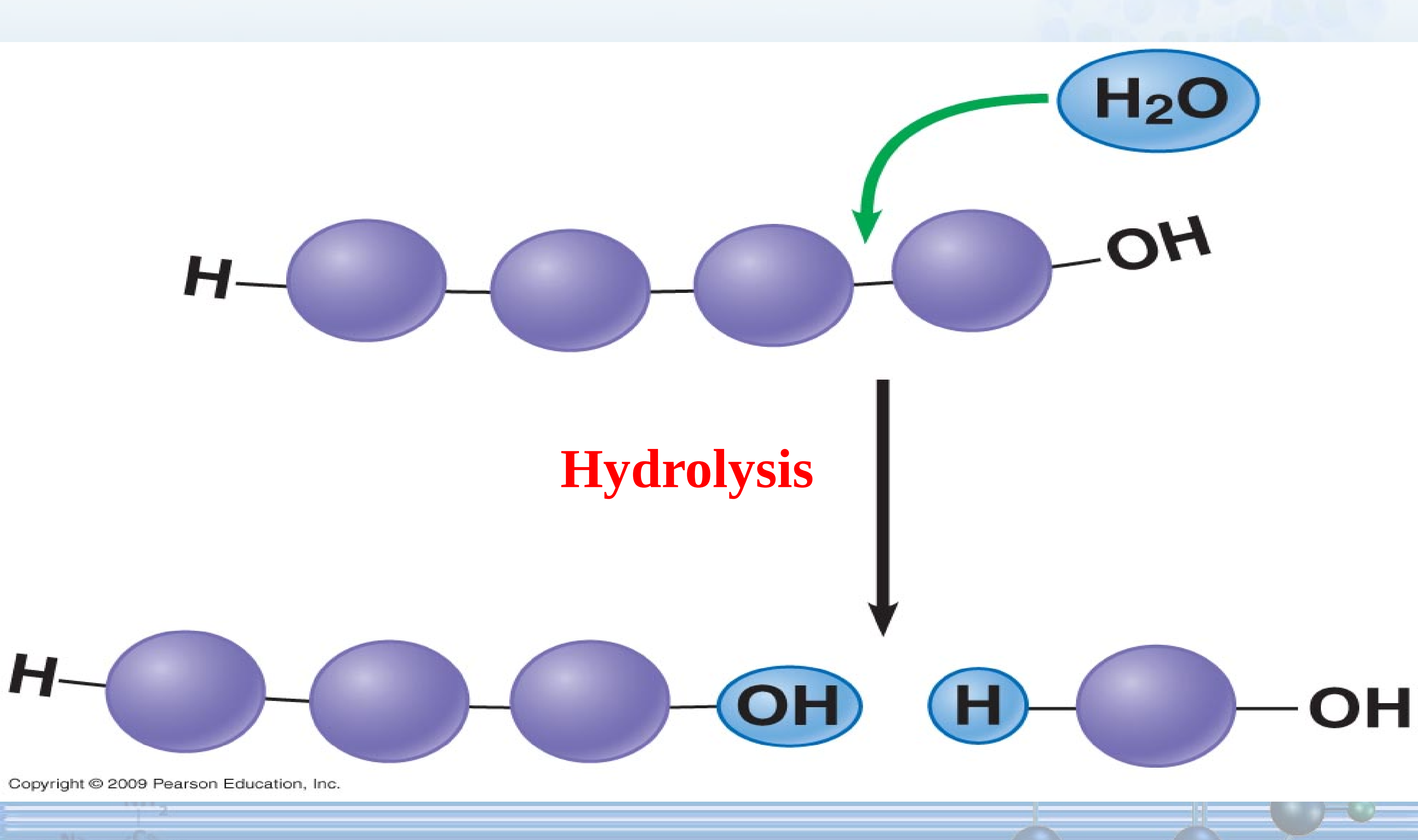
- Monomers are linked together to form polymers through dehydration reactions, which remove water
- Polymers are broken apart by hydrolysis, the addition of water
- All biological reactions of this sort are mediated by enzymes, which speed up chemical reactions in cells

PLAY Animation: Polymers

Dehydration reactions build a polymer chain



Hydrolysis breaks a polymer chain

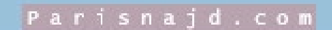


CARBOHYDRATES

ORGANIC COMPOUNDS (Molecules)

Monosaccharides are the simplest carbohydrates

- Carbohydrates range from small sugar molecules (monomers) to large polysaccharides
- Sugar monomers are monosaccharides, such as glucose and fructose
- These can be hooked together to form the polysaccharides

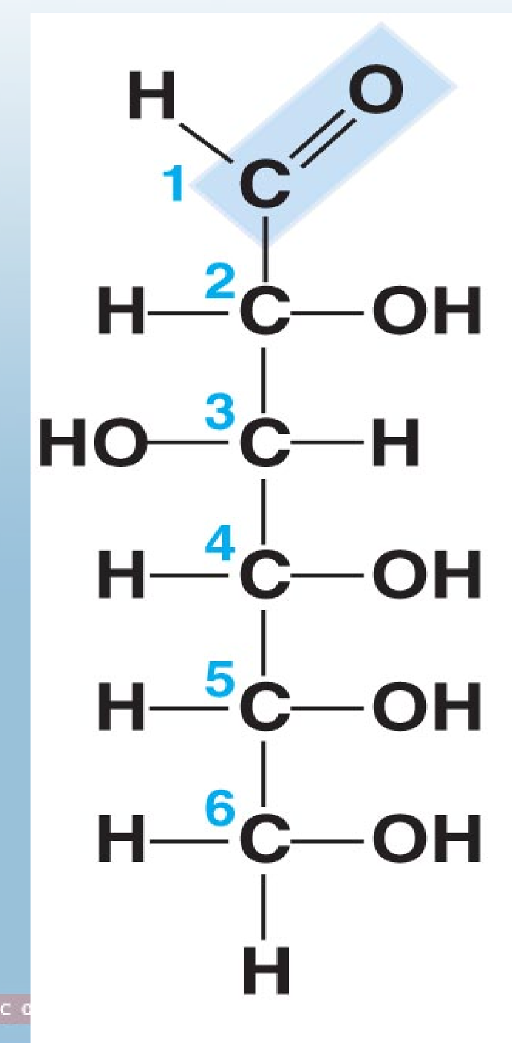


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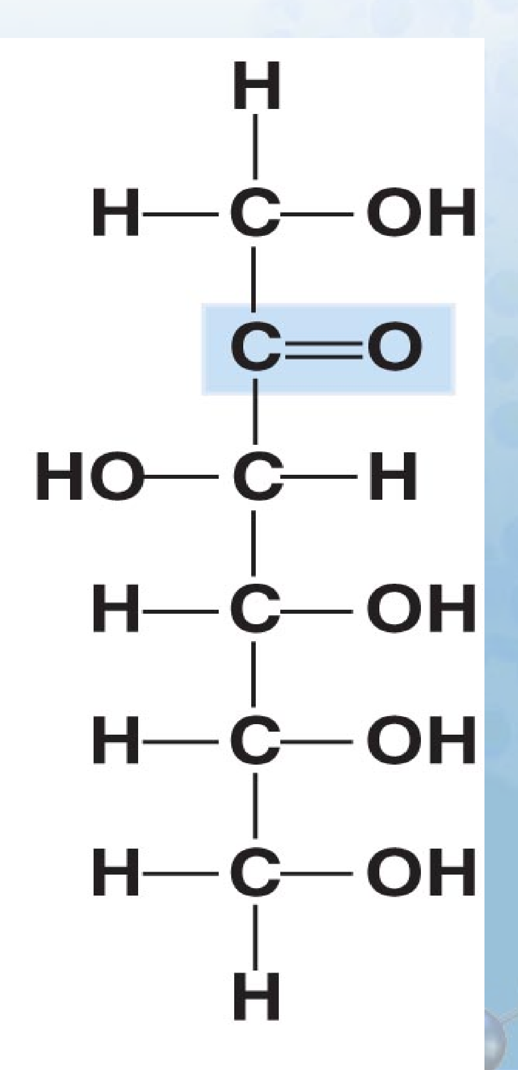
ORGANIC COMPOUNDS (Molecules)

- **The carbon skeletons of monosaccharides vary in length**
  - **Glucose and fructose are six carbons long**
  - **Others have three to seven carbon atoms**
- **Monosaccharides are the main fuels for cellular work**
  - **Monosaccharides are also used as raw materials to manufacture other organic molecules**

Structures of glucose and fructose ($C_6H_{12}O_6$)



Glucose
(an aldose)



Fructose
(a ketose)

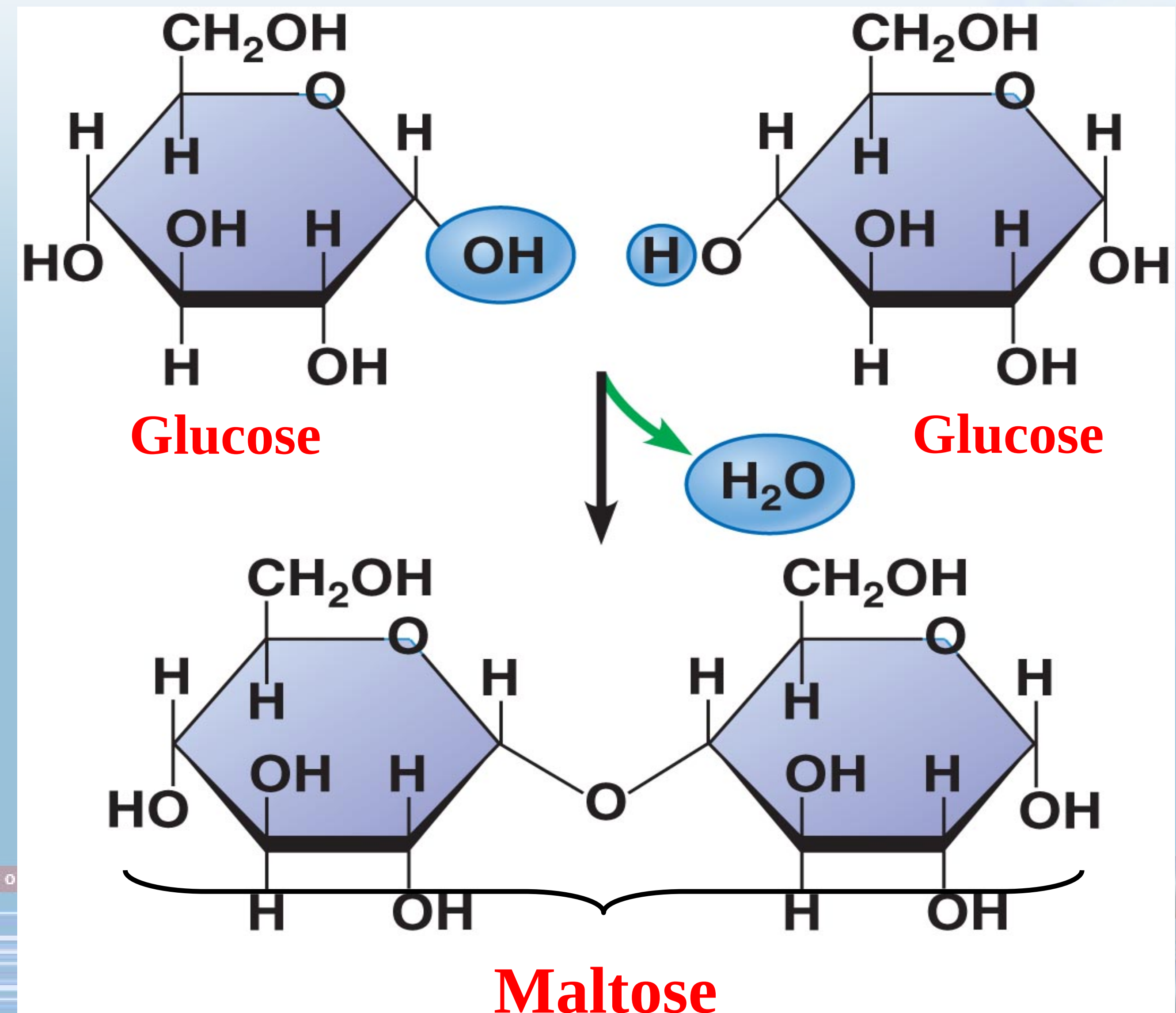
ORGANIC COMPOUNDS (Molecules)

Cells link two single sugars to form disaccharides

- Two monosaccharides (monomers) can bond to form a disaccharide in a dehydration reaction
- An example is glucose monomer bonding to a fructose monomer to form sucrose, a common disaccharide

PLAY Animation: Disaccharides

Disaccharide formation by a dehydration reaction

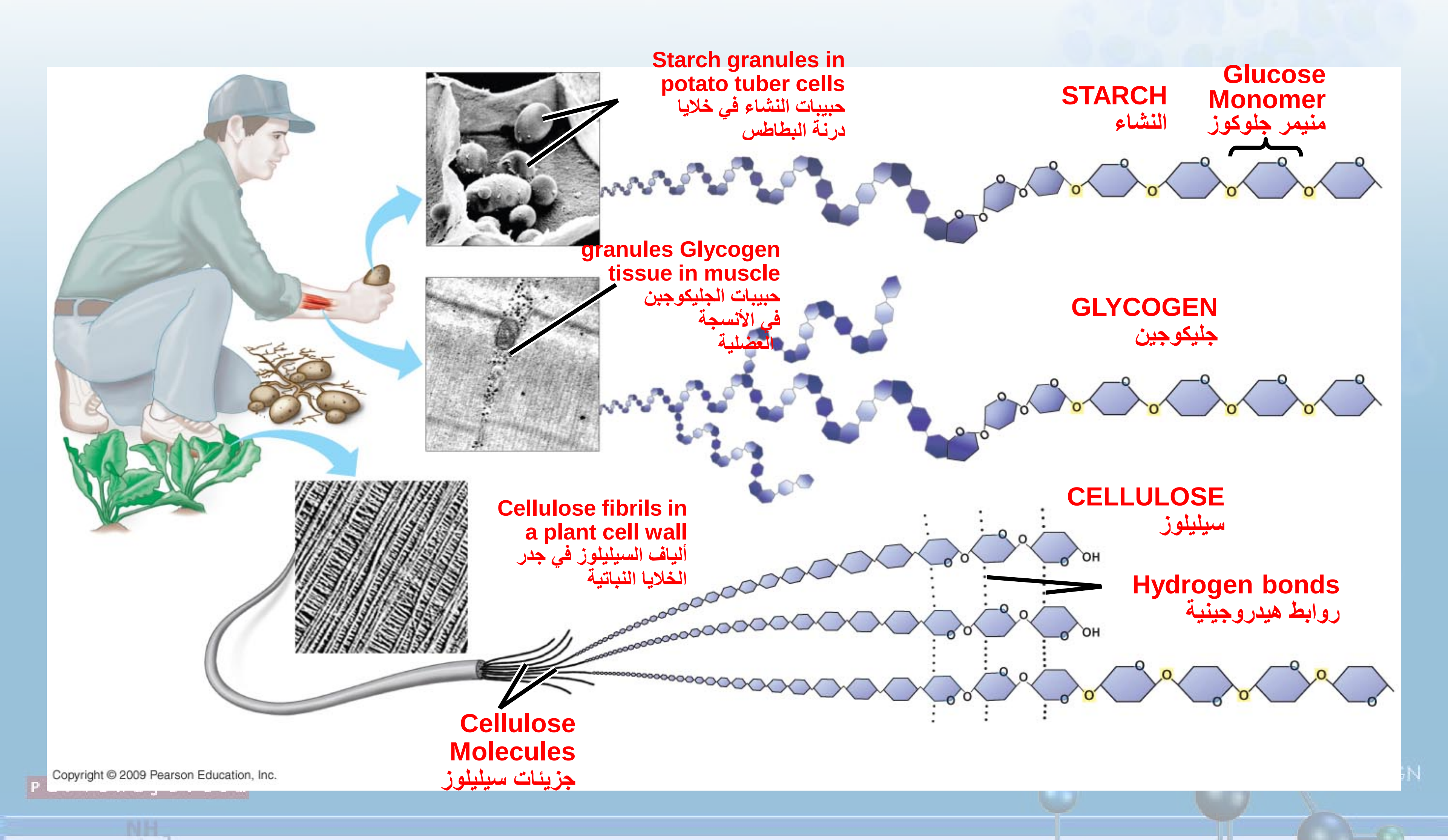


Polysaccharides are long chains of sugar units

- **Starch** is a storage polysaccharide composed of glucose monomers and found in plants
- **Glycogen** is a storage polysaccharide composed of glucose, which is hydrolyzed by animals when glucose is needed
- **Cellulose** is a polymer of glucose that forms plant cell walls
- **Chitin** is a polysaccharide used by insects and crustaceans to build an exoskeleton



Polysaccharides



LIPIDS

اللبيدات (الشحوميات)

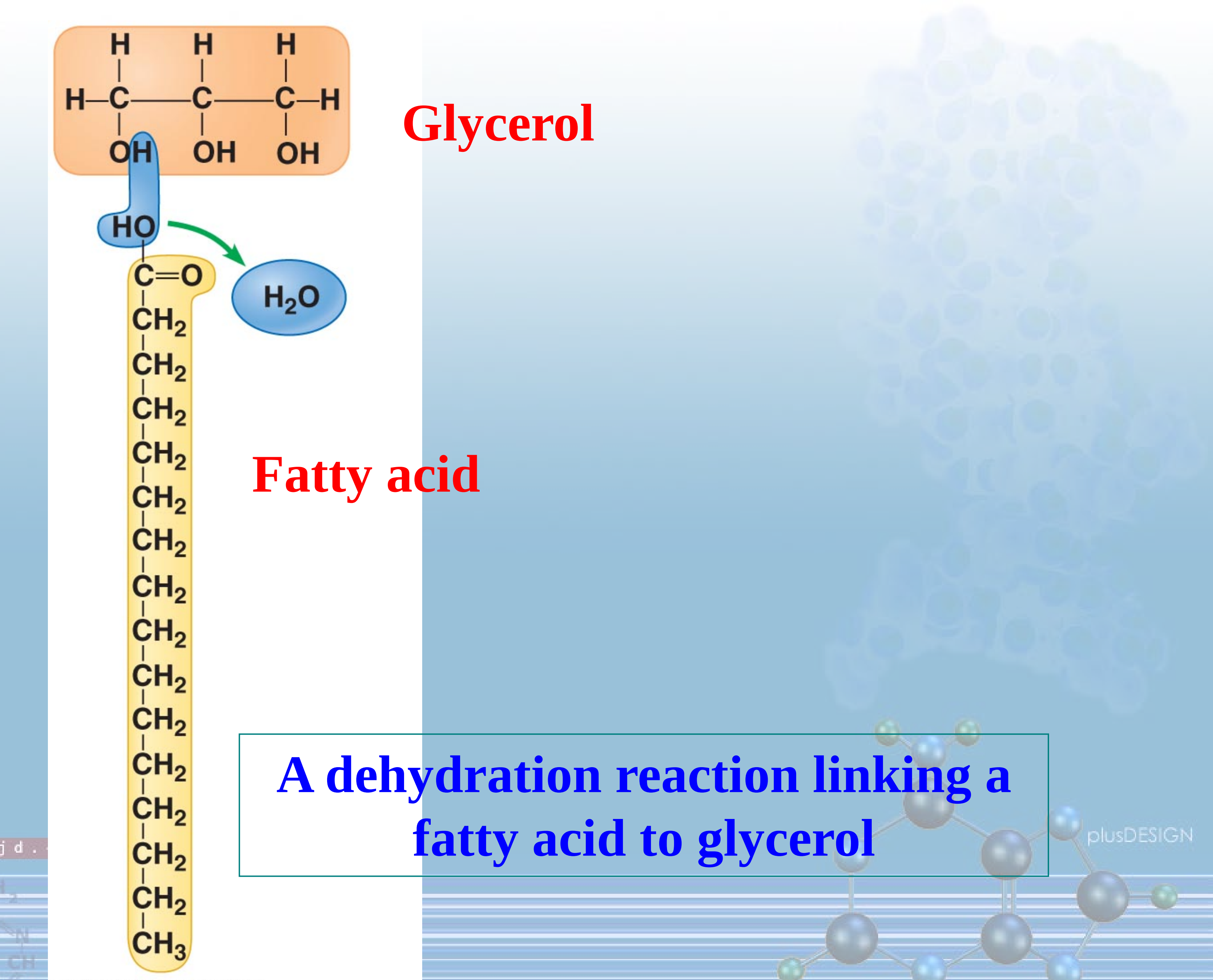
True Fats
الدهون الحقيقية

Phospholipids
اللبيدات (الدهون) الفسفورية

Steroids
الاستيرويدات

3.8 Fats are lipids that are mostly energy-storage molecules

- **Lipids are water insoluble (hydrophobic, or water fearing) compounds that are important in energy storage**
  - **They contain twice as much energy as a polysaccharide**
- **Fats are lipids made from glycerol and fatty acids**
- **Fatty acids link to glycerol by a dehydration reaction**
  - **A fat contains one glycerol linked to three fatty acids**
  - **Fats are often called triglycerides because of their structure**


H H H
H—C——C——C—H
OH OH OH
HO
C=O
H_2O
CH2
CH2
CH2
CH2
CH2
CH2
CH2
CH2
CH2
CH2
CH2
CH2
CH2
CH2
CH3
Glycerol
Fatty acid
A dehydration reaction linking a fatty acid to glycerol
plusDESIGN

A fat molecule made from glycerol and three fatty acids

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3.8 Fats are lipids that are mostly energy-storage molecules

- Some fatty acids contain double bonds

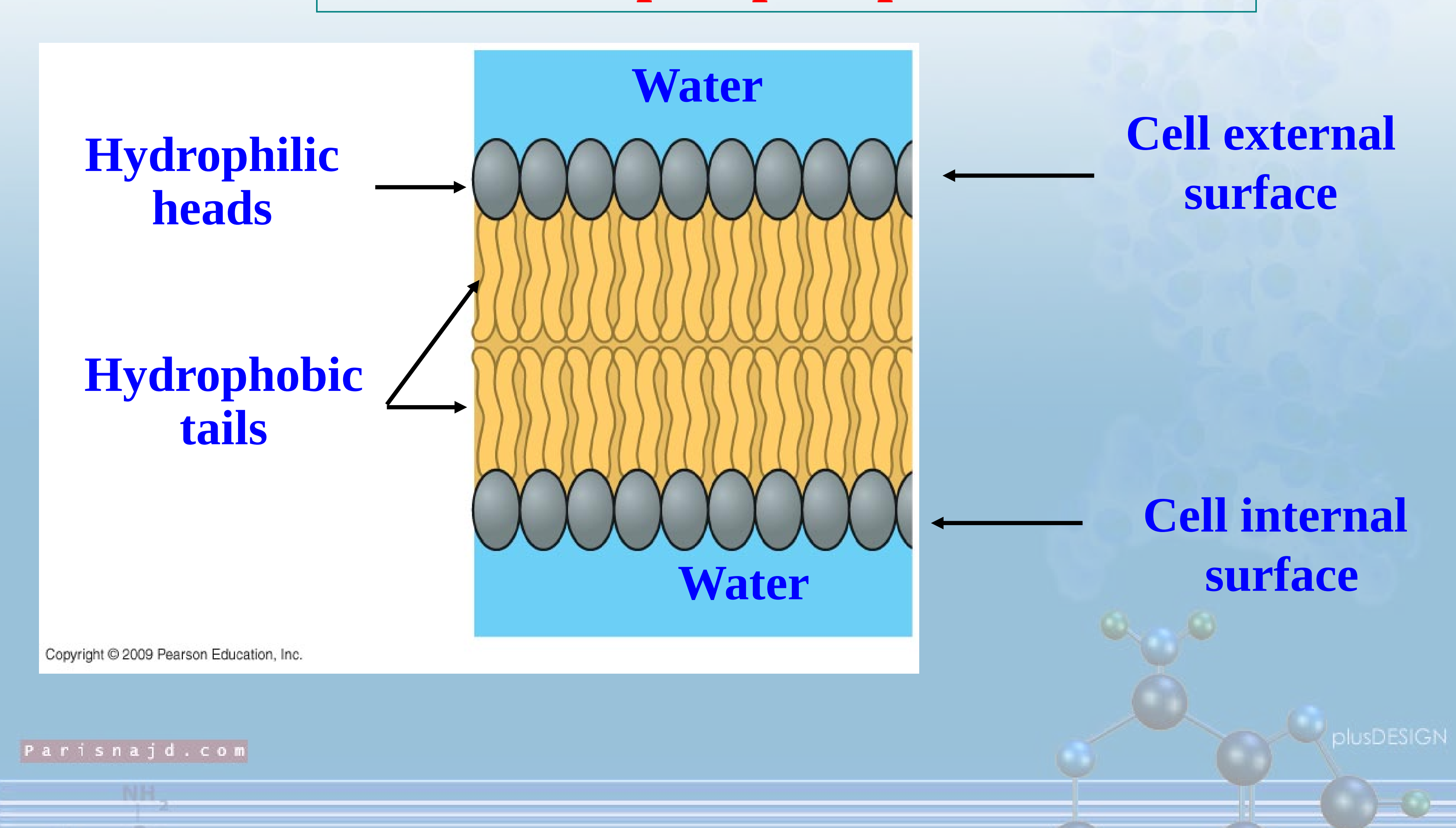
1. This causes kinks or bends in the carbon chain because the maximum number of hydrogen atoms cannot bond to the carbons at the double bond
2. These compounds are called unsaturated fats because they have fewer than the maximum number of hydrogens
3. Fats with the maximum number of hydrogens are called saturated fats

3.9 Phospholipids and steroids are important lipids with a variety of functions

- **Phospholipids are structurally similar to fats and are an important component of all cells**

1. For example, they are a major part of cell membranes, in which they cluster into a bilayer of phospholipids
2. The hydrophilic heads are in contact with the water of the environment and the internal part of the cell
3. The hydrophobic tails band in the center of the bilayer

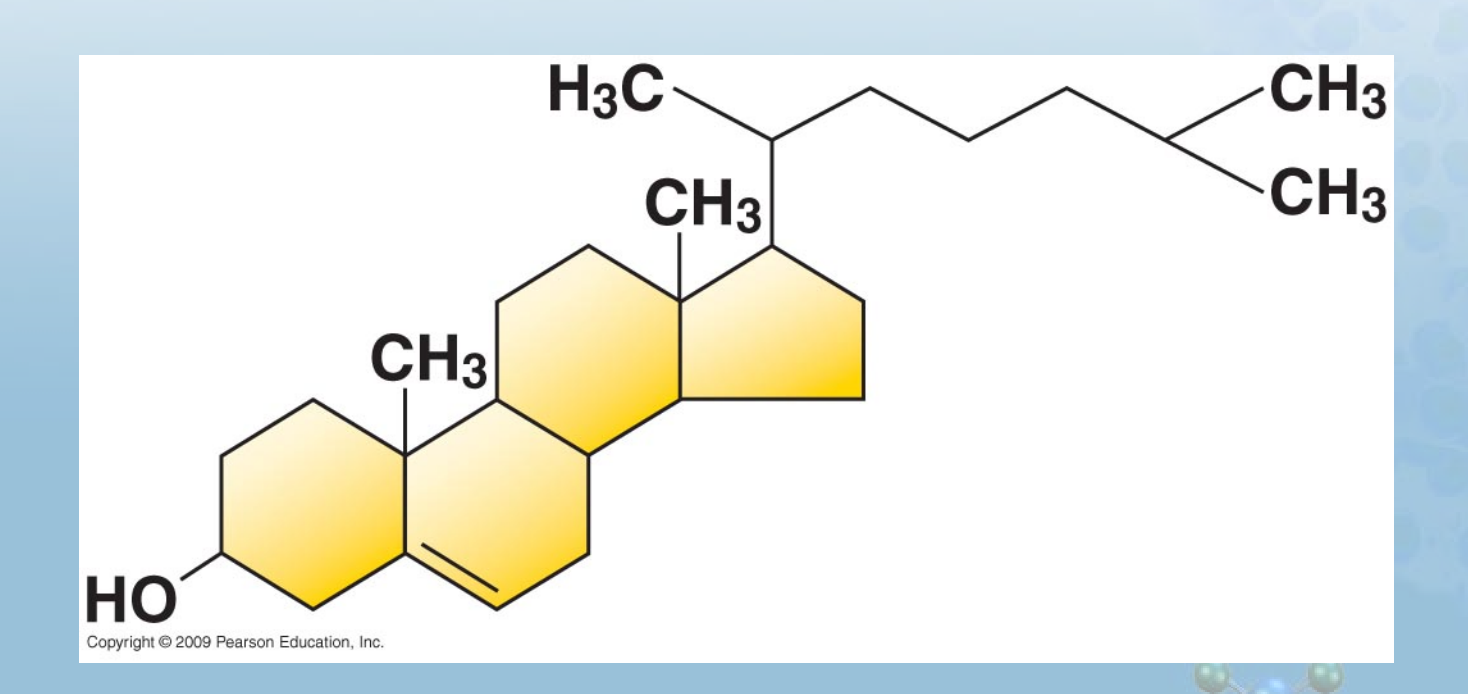
Section of a phospholipid membrane



3.9 Phospholipids and steroids are important lipids with a variety of functions

- **Steroids are lipids composed of fused ring structures**
- **Cholesterol is an example of a steroid that plays a significant role in the structure of the Cell Membrane**
- **In addition, cholesterol is the compound from which we synthesize Sex Hormones**

Cholesterol, a steroid



Differences in the chemical groups of sex hormones

Estradiol

OH

CH_3

HO



Female lion

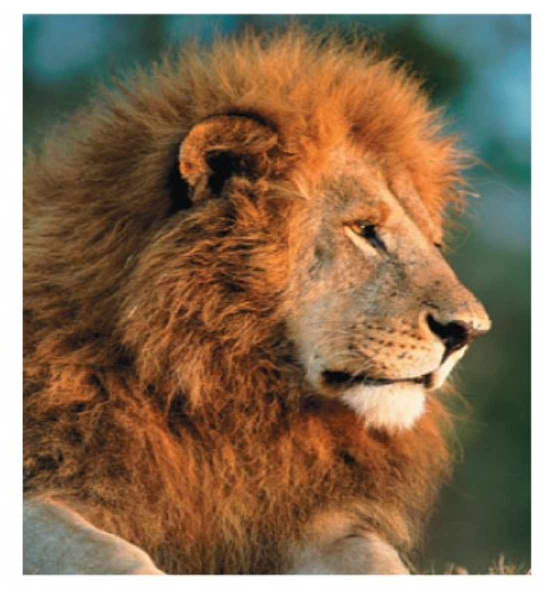
OH

CH_3

CH_3

O

Testosterone



Male lion

PROTEINS

3.11 Proteins are essential to the structures and functions of life

- **A protein is a polymer built from various combinations of 20 amino acid monomers**
  - **Proteins have unique structures that are directly related to their functions**
  - **Enzymes, proteins that serve as metabolic catalysts, regulate the chemical reactions within cells**

ORGANIC COMPOUNDS (Molecules)

- **Structural proteins provide associations between body parts**
- **Contractile proteins are found within muscle**
- **Defensive proteins include antibodies of the immune system**
- **Signal proteins are best exemplified by the hormones**
- **Receptor proteins serve as antenna for outside signals**
- **Transport proteins carry oxygen**

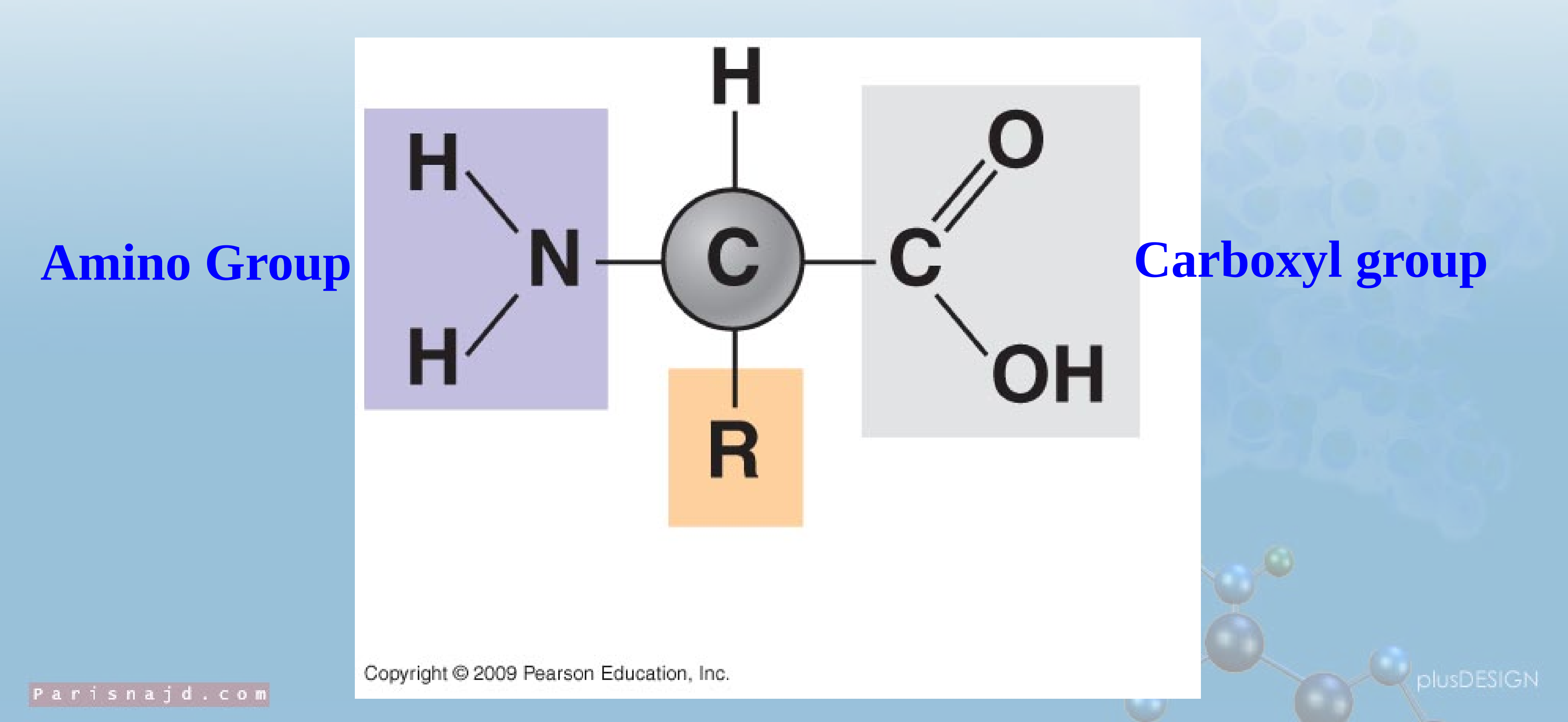


plusDESIGN

3.12 Proteins are made from amino acids linked by peptide bonds

- Amino acids, the building blocks of proteins, have an amino group and a carboxyl group
- covalently bonded to a central carbon atom
  - Also bonded to the central carbon is a hydrogen atom and some other chemical group symbolized by R

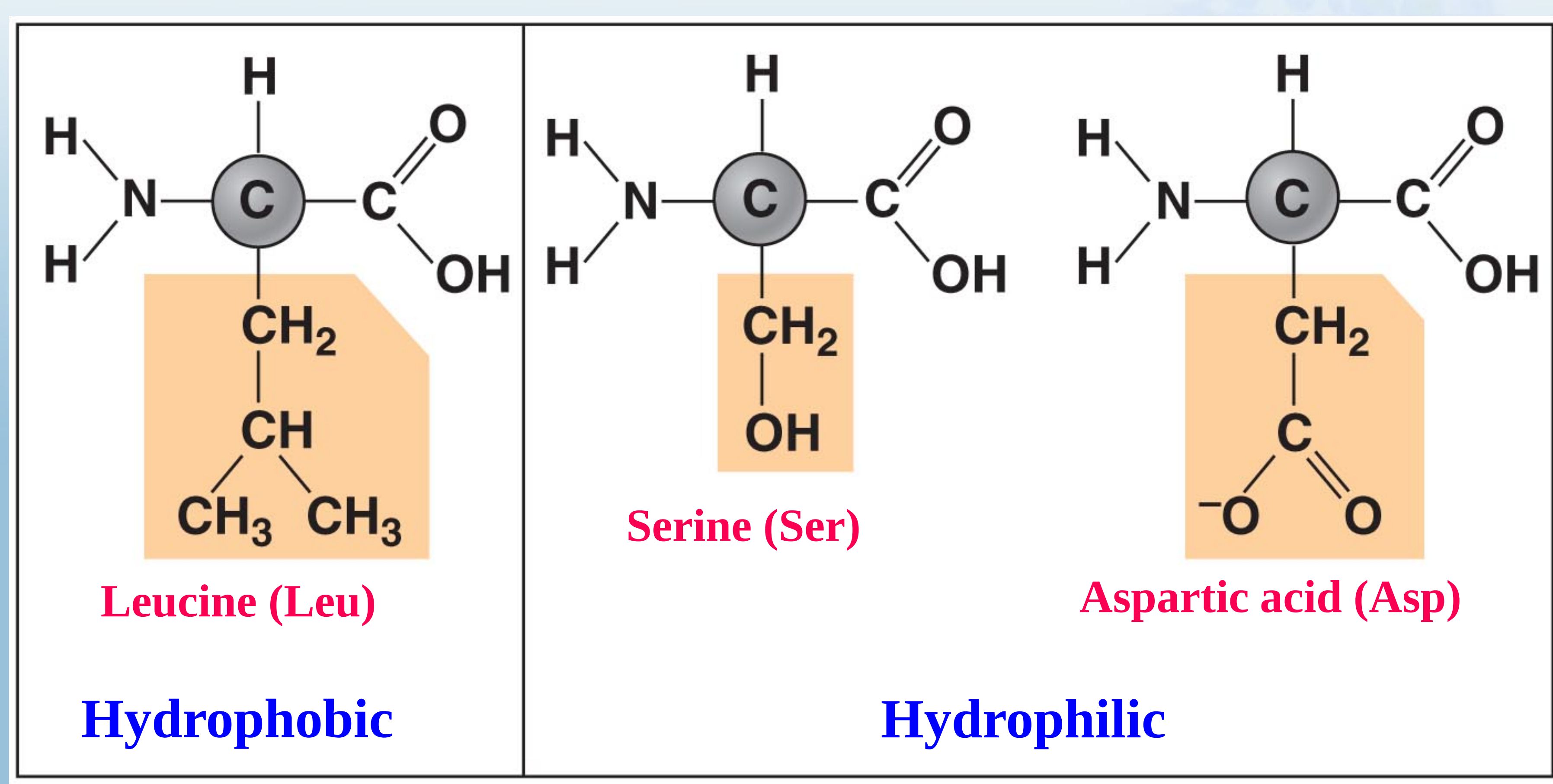
General structure of an amino acid



ORGANIC COMPOUNDS (Molecules)

- **Amino acids are classified as hydrophobic or hydrophilic**
  - **Some amino acids have a non-polar R group and are hydrophobic**
  - **Others have a polar R group and are hydrophilic, which means they easily dissolve in aqueous solutions**

Examples of amino acids with hydrophobic and hydrophilic R groups



ORGANIC COMPOUNDS (Molecules)

- **Amino acid monomers are linked together to form polymeric proteins**
  - **This is accomplished by an enzyme-mediated dehydration reaction**
  - **This links the carboxyl group (COOH) of one amino acid to the amino group (NH_2) of the next amino acid. The covalent linkage resulting is called a peptide bond**

plusDESIGN

Peptide bond formation

Carboxyl group

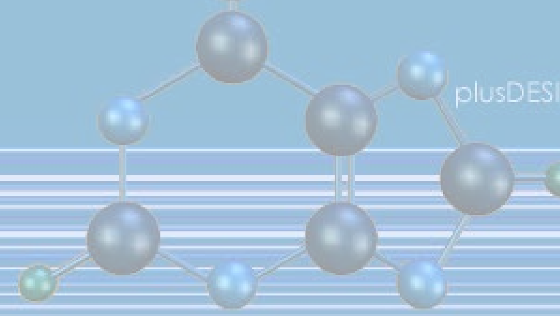
Amino group

Dehydration reaction

Peptide bond

H_2O

Amino acid + Amino acid → Dipeptide



3.13 A protein's specific shape determines its function

- A polypeptide chain contains hundreds or thousands of amino acids linked by peptide bonds
  - The amino acid sequence causes the polypeptide to assume a particular shape
  - The shape of a protein determines its specific function

3.14 A protein's shape depends on four levels of structure

- A protein can have four levels of structure
  - Primary structure التركيب الاولي
  - Secondary structure التركيب الثانوي
  - Tertiary structure التركيب الثالثي
  - Quaternary structure التركيب الرباعي

3.14 A protein's shape depends on four levels of structure

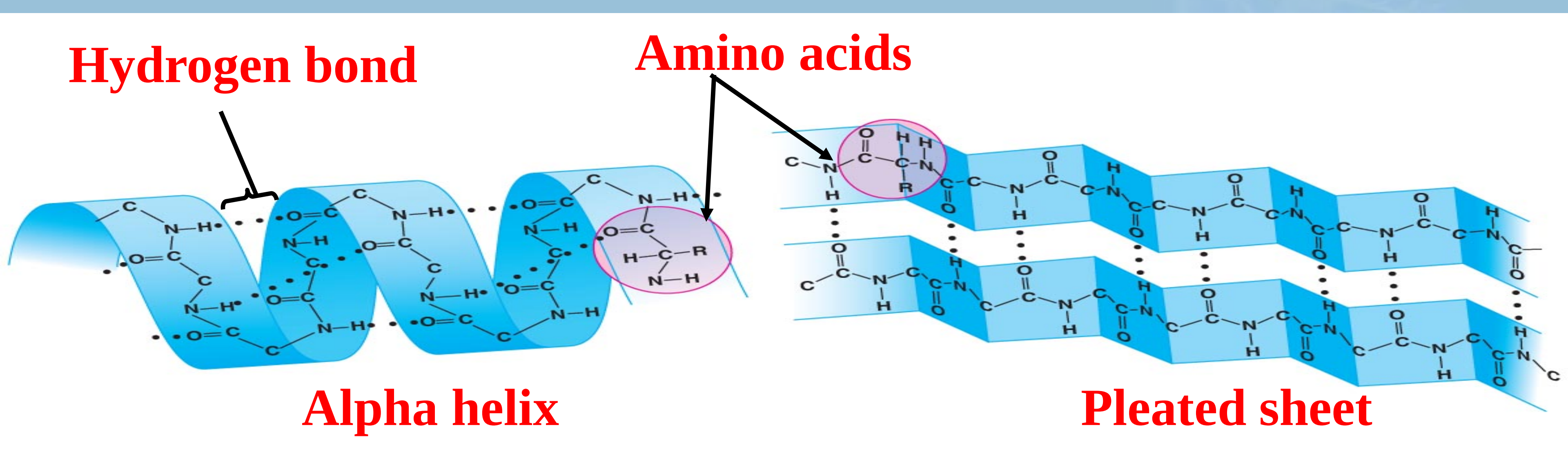
- The primary structure of a protein is its unique amino acid sequence
  - The correct amino acid sequence is determined by the cell's genetic information
  - The slightest change in this sequence affects the protein's ability to function



Primary structure

ORGANIC COMPOUNDS (Molecules)

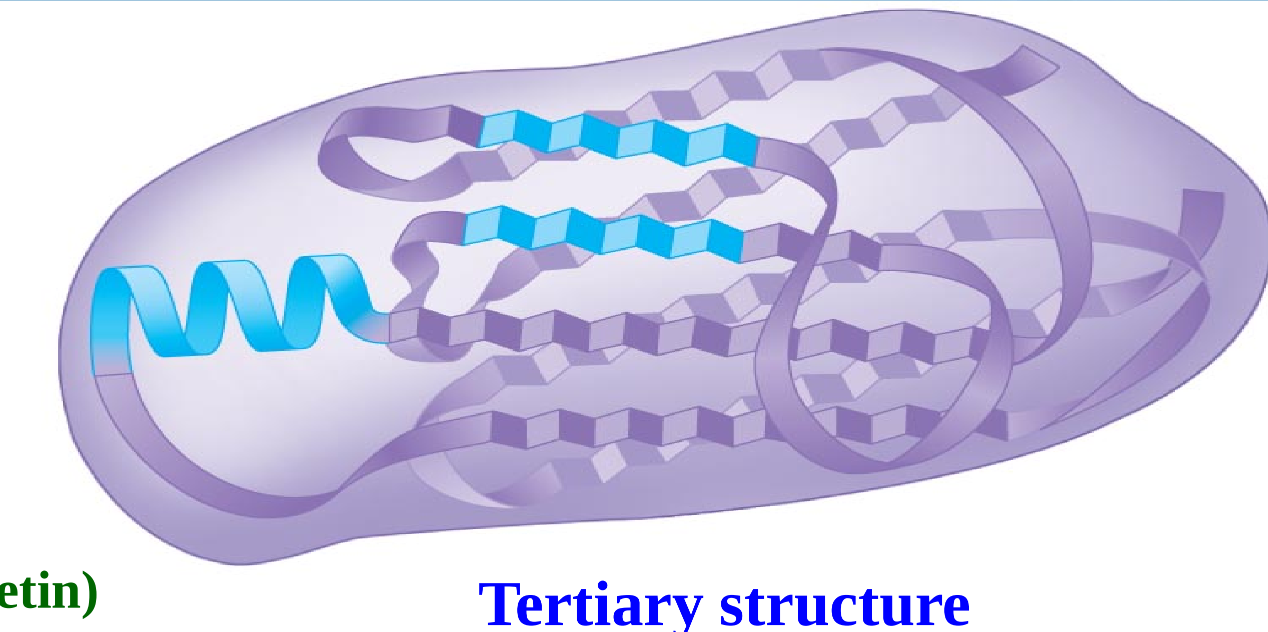
- **Protein secondary structure results from coiling or folding of the polypeptide**
  - **Coiling results in a helical structure called an alpha helix**
  - **Folding may lead to a structure called a pleated sheet**
  - **Coiling and folding result from hydrogen bonding between certain areas of the polypeptide chain**



Secondary structure

ORGANIC COMPOUNDS (Molecules)

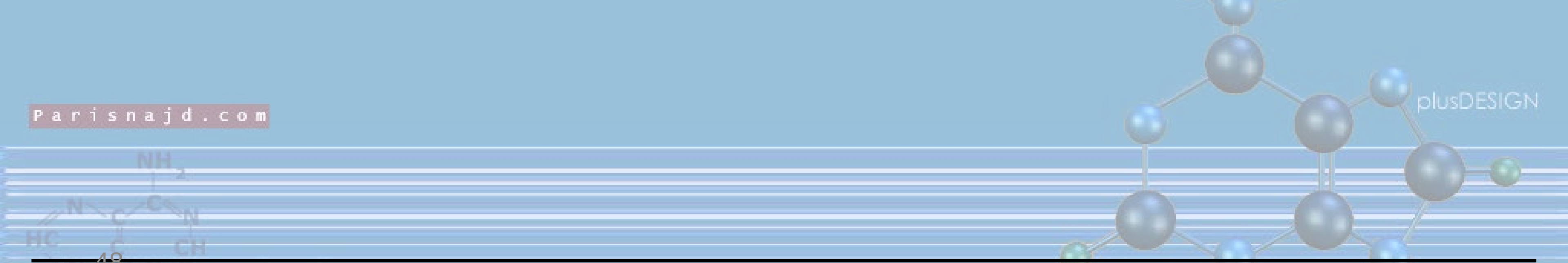
- **The overall three-dimensional shape of a protein is called its tertiary structure**
  - **Tertiary structure generally results from interactions between the R groups of the various amino acids**
  - **Disulfide bridges are covalent bonds that further strengthen the protein's shape**



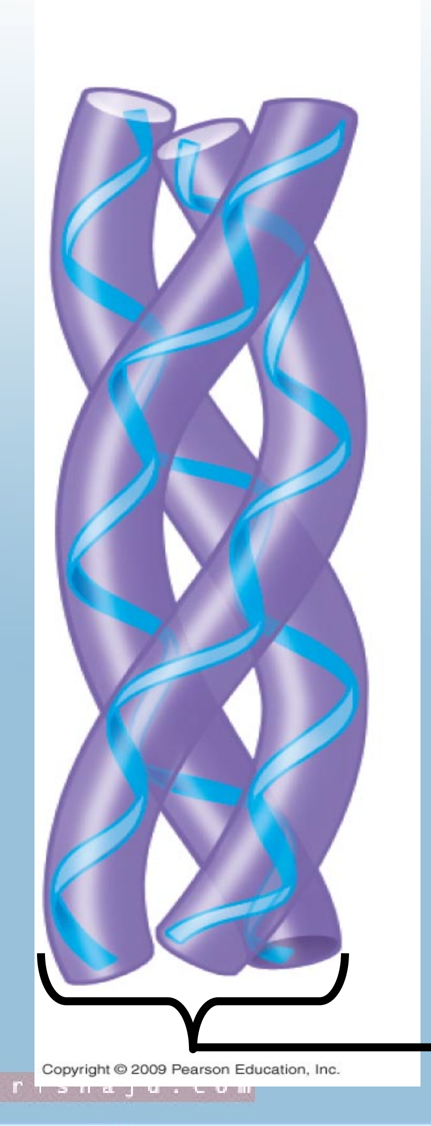
Globular Polypeptide (single subunit of transthyretin)

Tertiary structure

- **Two or more polypeptide chains (subunits) associate providing quaternary structure**
  - **Collagen is an example of a protein with quaternary structure**
  - **Its triple helix gives great strength to connective tissue, bone, tendons and ligaments**



Polypeptide chain (alpha helix)

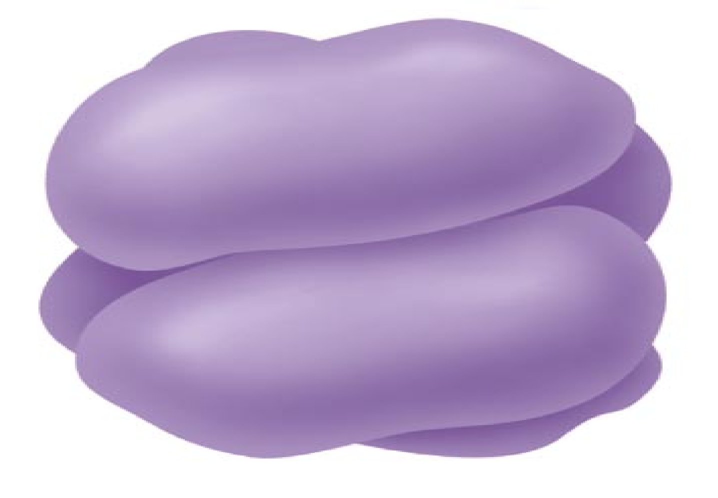


- **Collagen is a fibrous protein with helical subunits interwind into a larger triple helix.**
- **This arrangement gives the long fibers great strength**

Triple helix

Collagen fiber

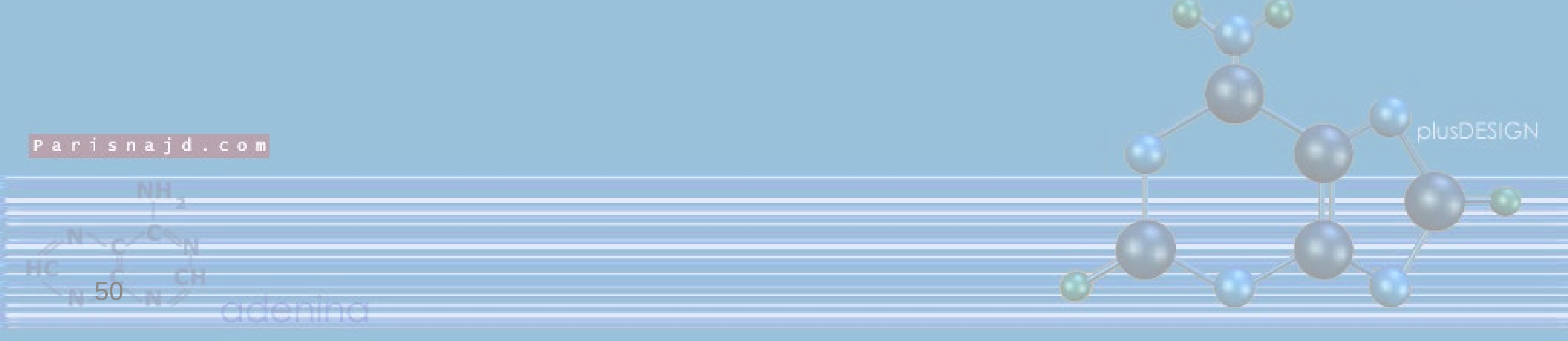
Transthyretin, with four identical globular polypeptide subunits

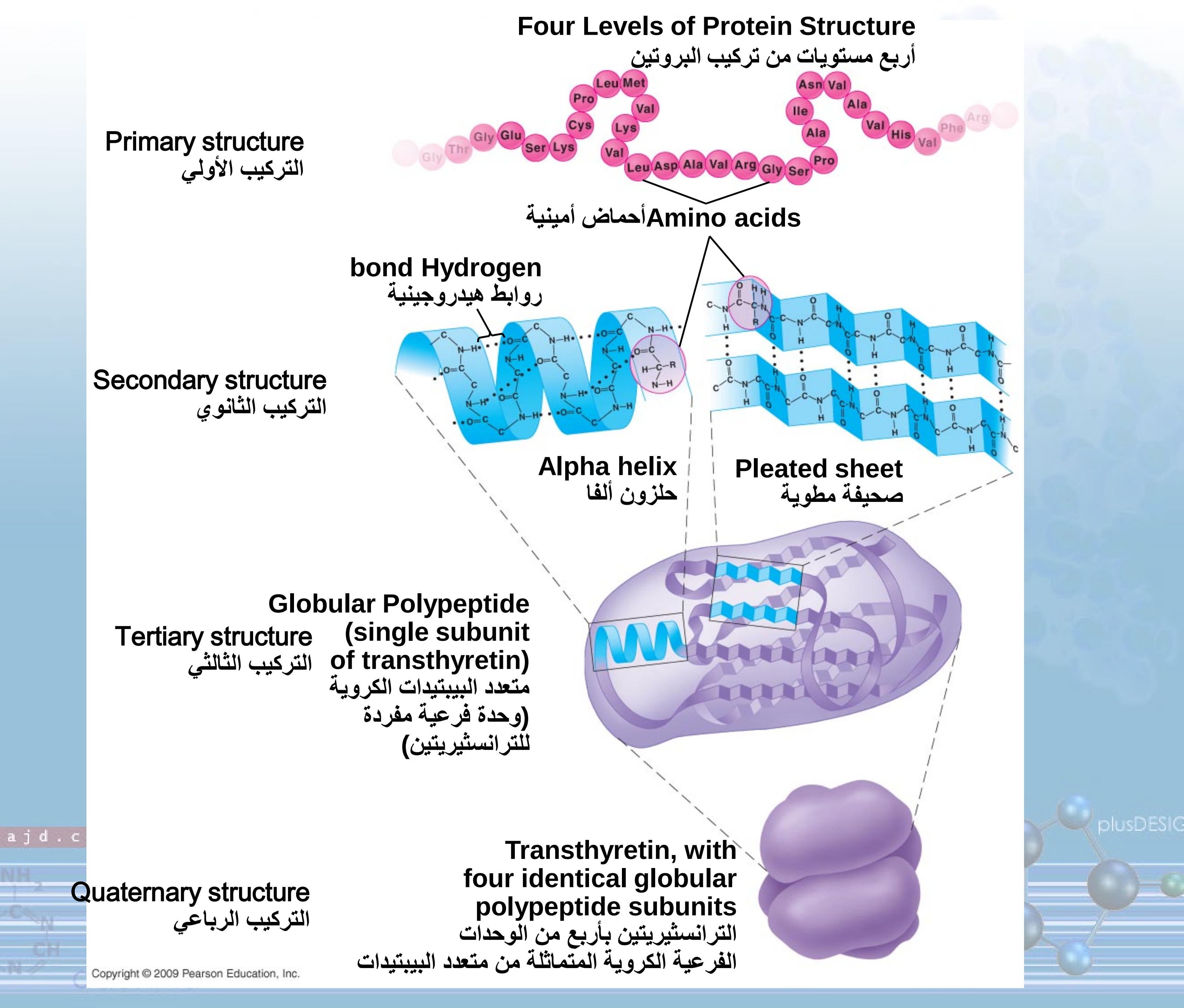


Quaternary structure

Transthyretin:

A plasma protein consisting of 127 amino acids that binds retinol and thyroxine



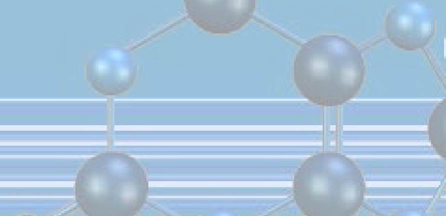

Four Levels of Protein Structure
أربع مستويات من تركيب البروتين
Primary structure
التركيب الأولي
Gly Thr Gly Glu Ser Lys Cys Pro Leu Met Val Lys Val Leu Asp Ala Val Arg Gly Ser Pro Ala Ile Asn Val Ala Val His Val Phe Arg
Amino acids أحماض أمينية
bond Hydrogen
روابط هيدروجينية
Secondary structure
التركيب الثانوي
Alpha helix
حلزون ألفا
Pleated sheet
صحيفة مطوية
Tertiary structure
التركيب الثالثي
Globular Polypeptide (single subunit of transthyretin)
متعدد الببتيدات الكروية (وحدة فرعية مفردة للترانسثيريتين)
Quaternary structure
التركيب الرباعي
Transthyretin, with four identical globular polypeptide subunits
الترانسثيريتين بأربع من الوحدات الفرعية الكروية المتماثلة من متعدد الببتيدات
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3.13 A protein's specific shape determines its function

- **If for some reason a protein's shape is altered, it can no longer function**
  - **Denaturation will cause polypeptide chains to unravel and lose their shape and, thus, their function**
  - **Proteins can be denatured by changes in salt concentration and pH**



NUCLEIC ACIDS

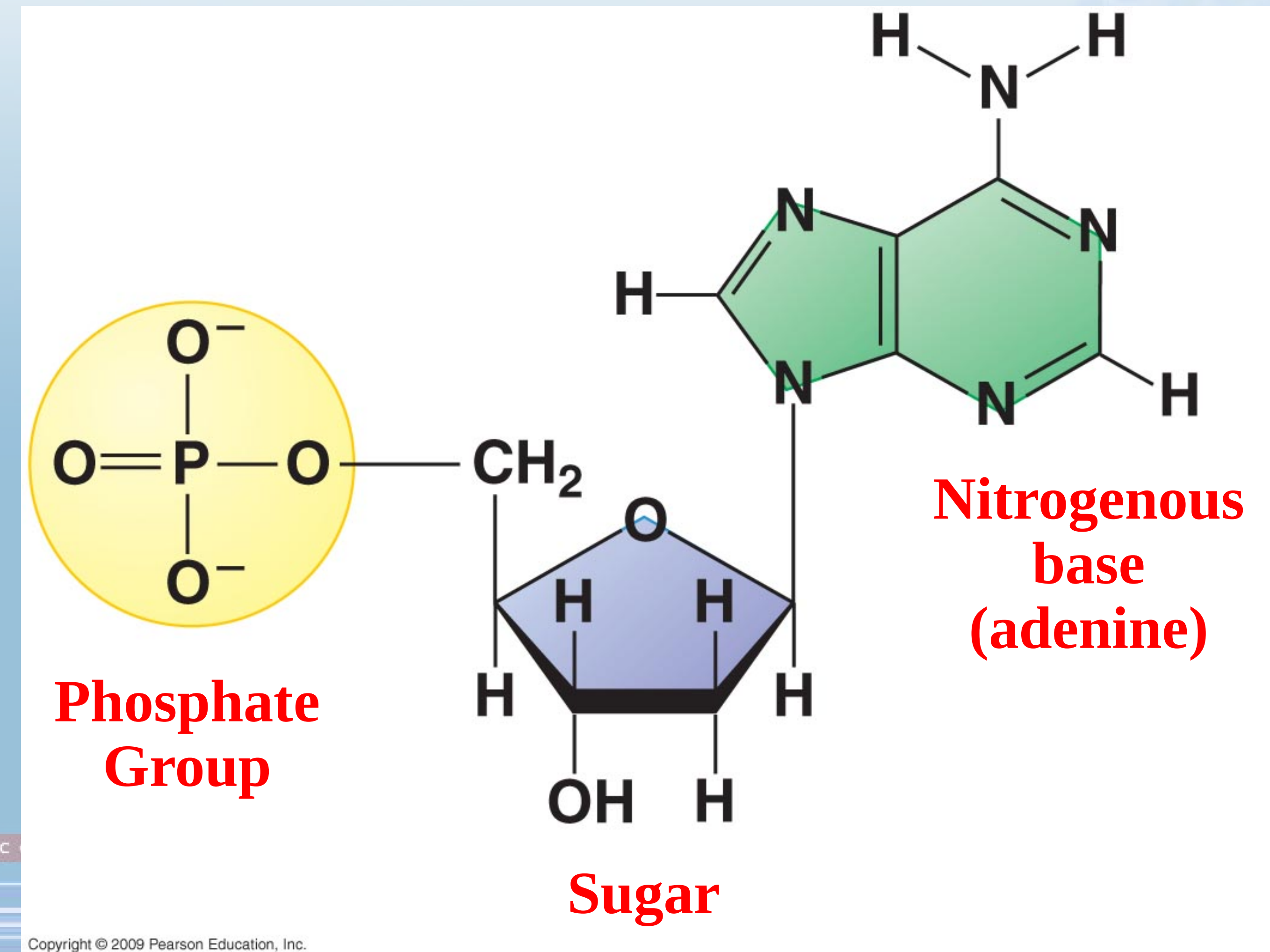


3.16 Nucleic acids are information-rich polymers of nucleotides

- **DNA (deoxyribonucleic acid) and RNA (ribonucleic acid) are composed of monomers called nucleotides**
  - **Nucleotides have three parts**
    1. **A five-carbon sugar called ribose in RNA and deoxyribose in DNA**
    2. **A phosphate group**
    3. **A nitrogenous base**



Nucleotide, consisting of a phosphate group, sugar, and a nitrogenous base



H_2O

Dehydration

... OH + H — H ⇌ ... — H

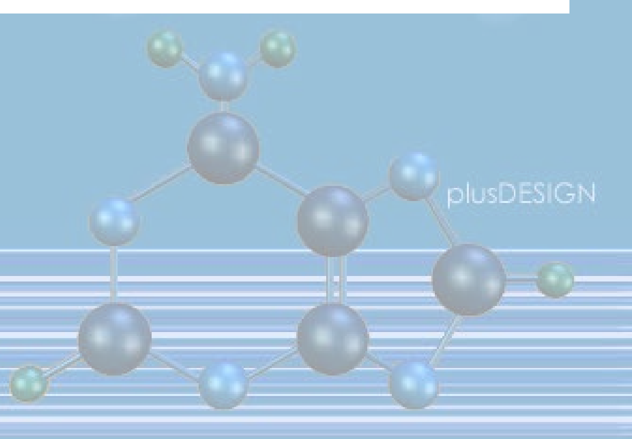
Hydrolysis

Short polymer

Monomer

Longer polymer

H_2O

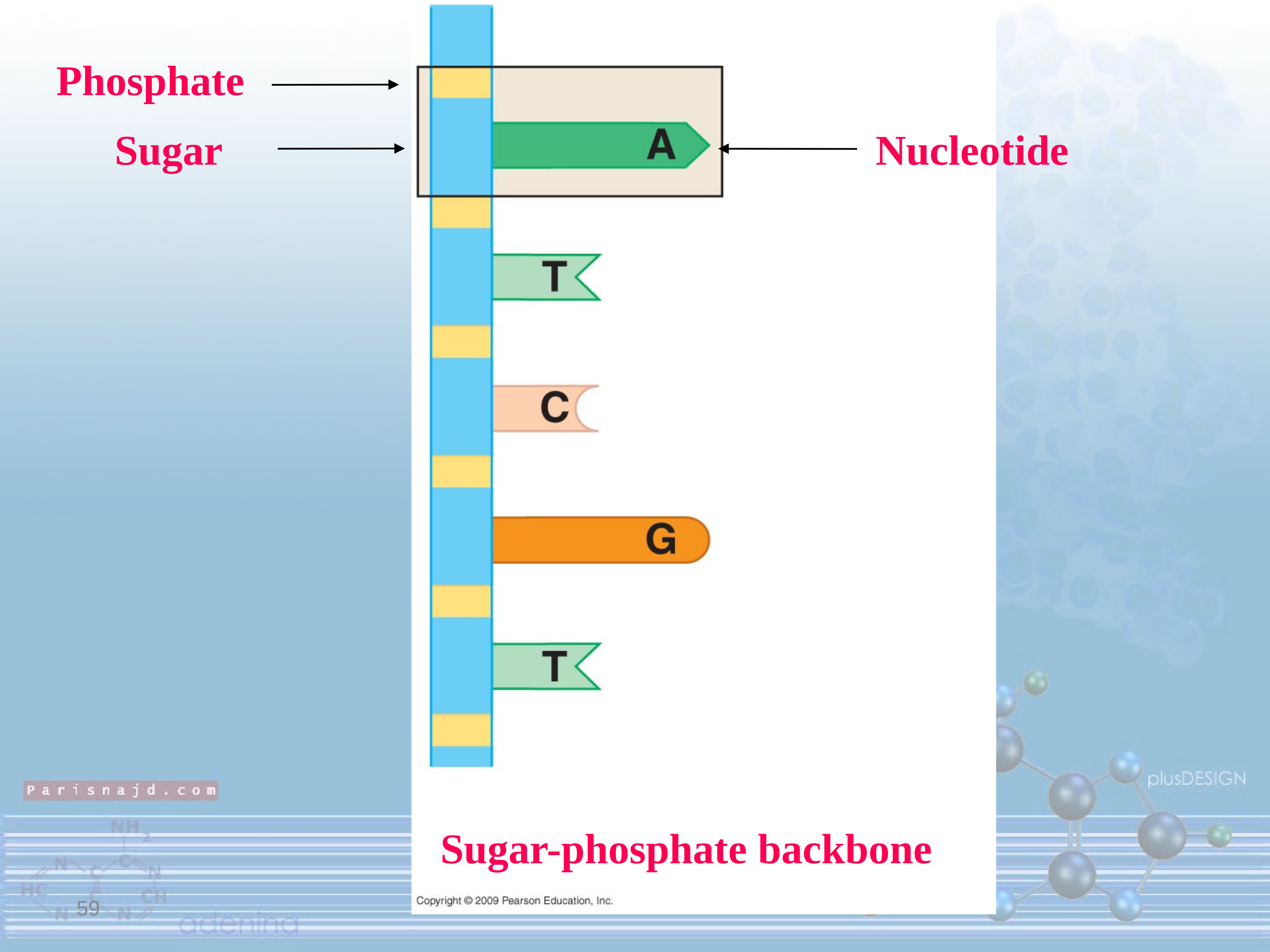


3.16 Nucleic acids are information-rich polymers of nucleotides

- **DNA nitrogenous bases are:**
- **adenine (A), thymine (T), cytosine (C), and guanine (G)**
- **RNA also has A, C, and G, but instead of thymine (T), it has uracil (U)**

3.16 Nucleic acids are information-rich polymers of nucleotides

- A nucleic acid polymer is a **polynucleotide**. It is formed when the **phosphate group** of a nucleotide monomer bonds to the **sugar** of the next nucleotide
- The result is a repeating **sugar-phosphate backbone** with protruding **nitrogenous bases**



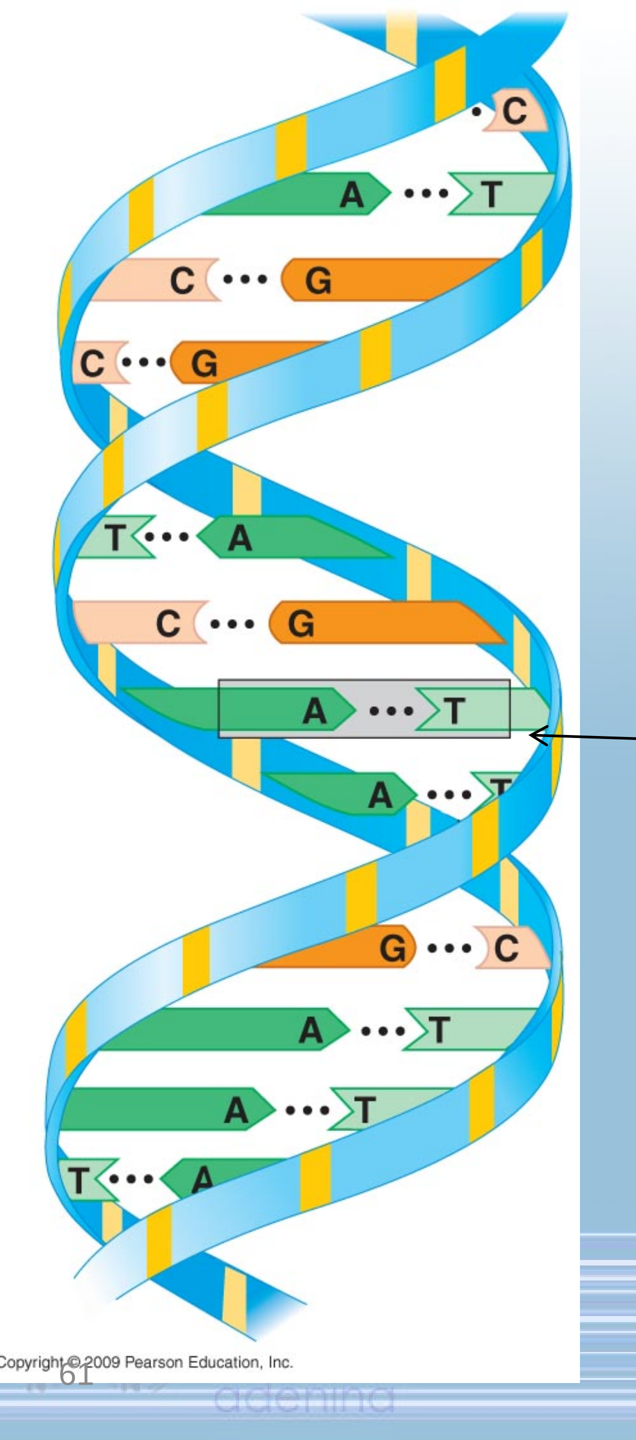
Phosphate
Sugar
A
Nucleotide
T
C
G
T
Sugar-phosphate backbone
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3.16 Nucleic acids are information-rich polymers of nucleotides

- Two polynucleotide strands wrap around each other to form a DNA double helix
  - The two strands are associated because particular bases always hydrogen bond to one another
  - Usually A pairs with T, and C pairs with G, producing base pairs
- RNA is usually a single polynucleotide strand



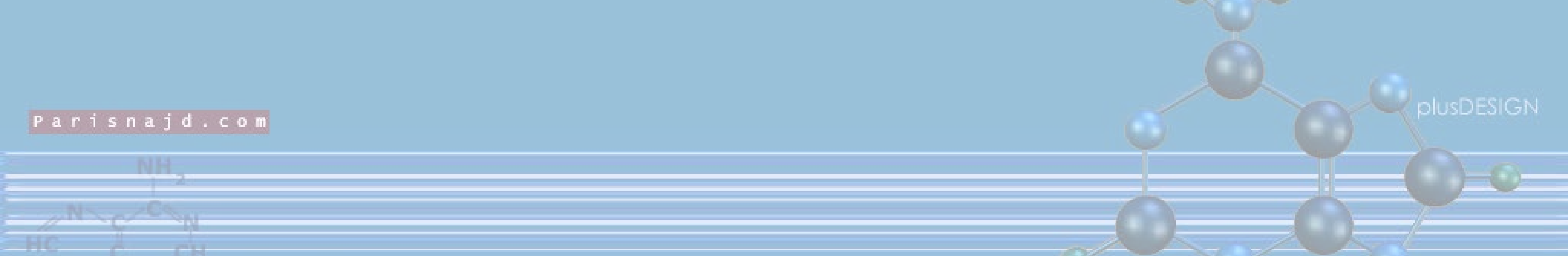
DNA double helix



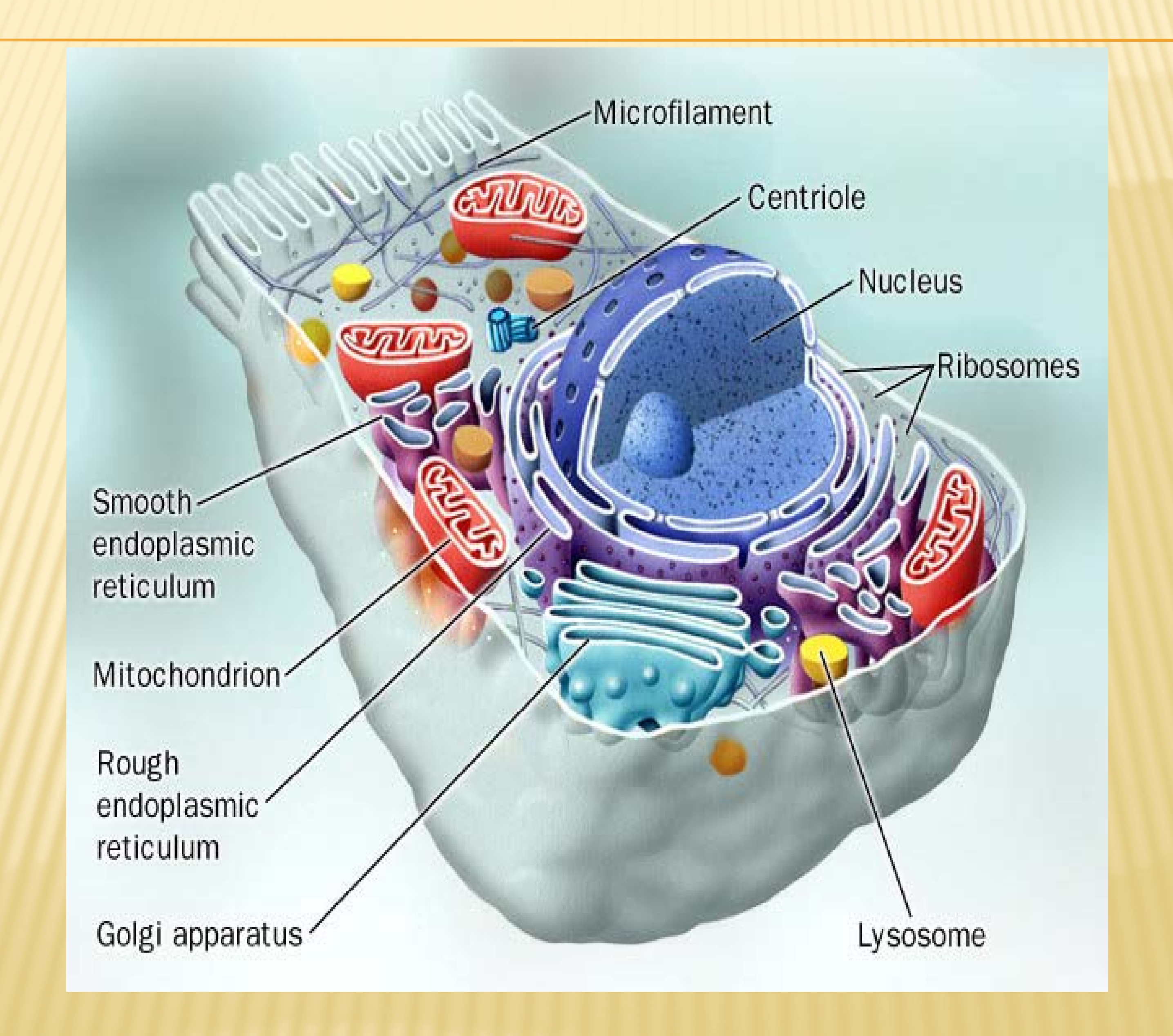
Base pair

ORGANIC COMPOUNDS (Molecules)

- A particular nucleotide sequence that can instruct the formation of a polypeptide is called a **gene**
  - Most DNA molecules consist of millions of base pairs and, consequently, many genes
  - These genes, many of which are unique to the species, determine the structure of proteins and, thus, life's structures and functions



Chapter 4 The Cell



1) Cell Theory

1) **All organisms are composed of one or more cells**

2) **The cell is the simplest structure that can perform all activities required for life**

3) **All cells come from other pre-existing cells by cell division**

Microscopes



- **A variety of microscopes have been developed for a clearer view of cells and cellular structure**

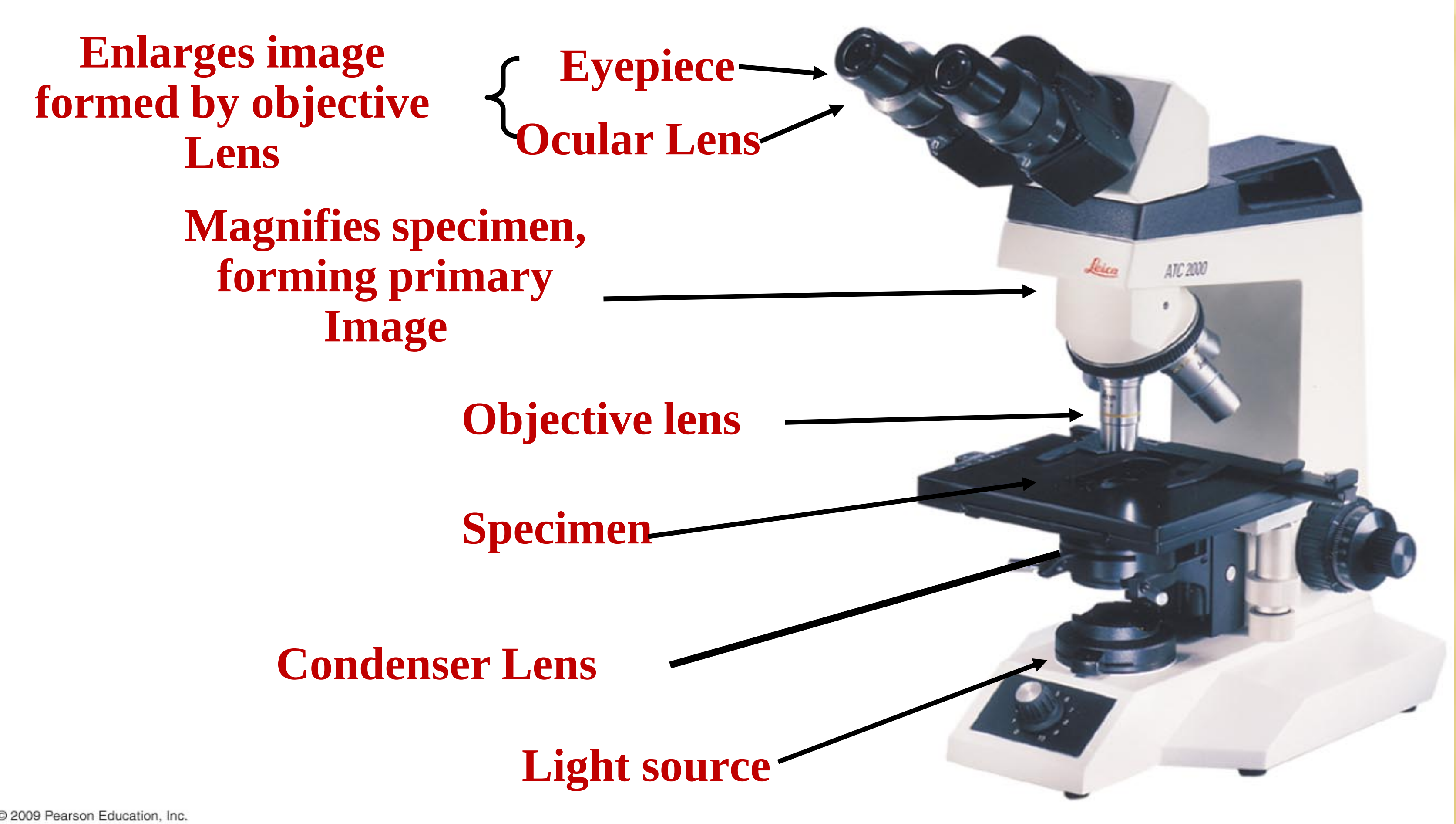
- **The most frequently used microscope is the light microscope (LM) — like the one used in biology laboratories**

- **Light passes through a specimen then through glass lenses into the viewer's eye**

- **Specimens can be magnified up to 1,000 times the actual size of the specimen**

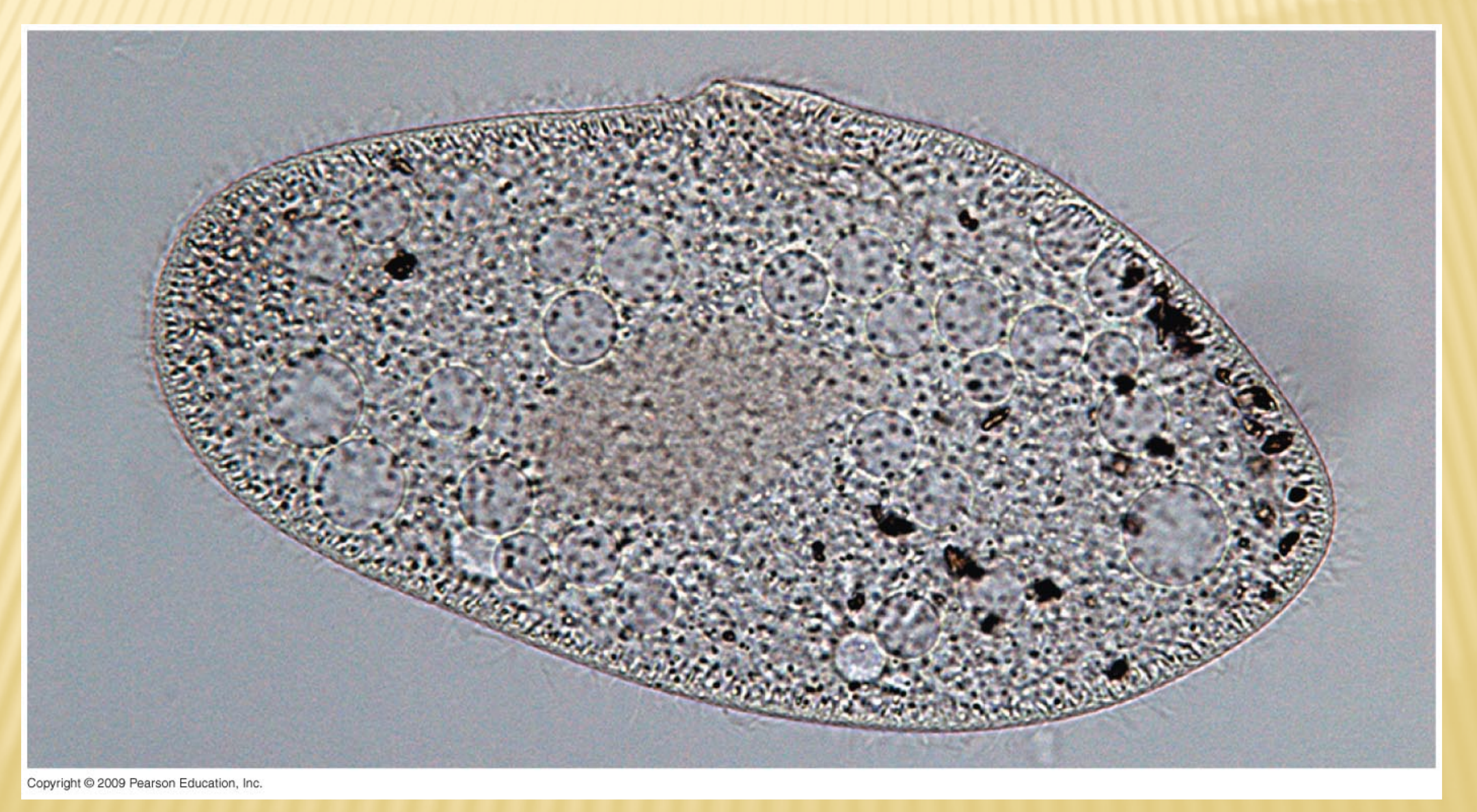
Microscopes

Light microscope (LM)



Microscopes

Light Micrograph (LM) of a protist, *Paramecium*.



Microscopes reveal the world of the cell

- **Biologists often use a very powerful microscope called the electron microscope (EM) to view the ultrastructure of cells**
  - **It can resolve biological structures as small as 2 nanometers (nm) and can magnify up to 100,000 times**
  - **Instead of light, the EM uses a beam of electrons**

Microscopes

Scanning Electron Micrograph (SEM) of *Paramecium*.



Microscopes

Transmission Electron Micrograph (TEM) of *Paramecium*



Most cells are microscopic

- **The surface area of a cell is important for carrying out the cell's functions, such as acquiring adequate nutrients and oxygen**
  - **A small cell has more surface area relative to its cell volume and is more efficient**

Number of Cells

Organisms may be:

1) ***Unicellular* –** **composed of** **one cell like bacteria**

2) ***Multicellular-*** **composed of** ***many cells*** **that may organize**

Type of Cells

There are two major types of cells

1. **Prokaryotic cells include bacteria & lack a nucleus or membrane-bound structures called organelles**

2. **Eukaryotic cells include most other cells & have a nucleus and membrane-bound organelles (plants, fungi, & animals)**

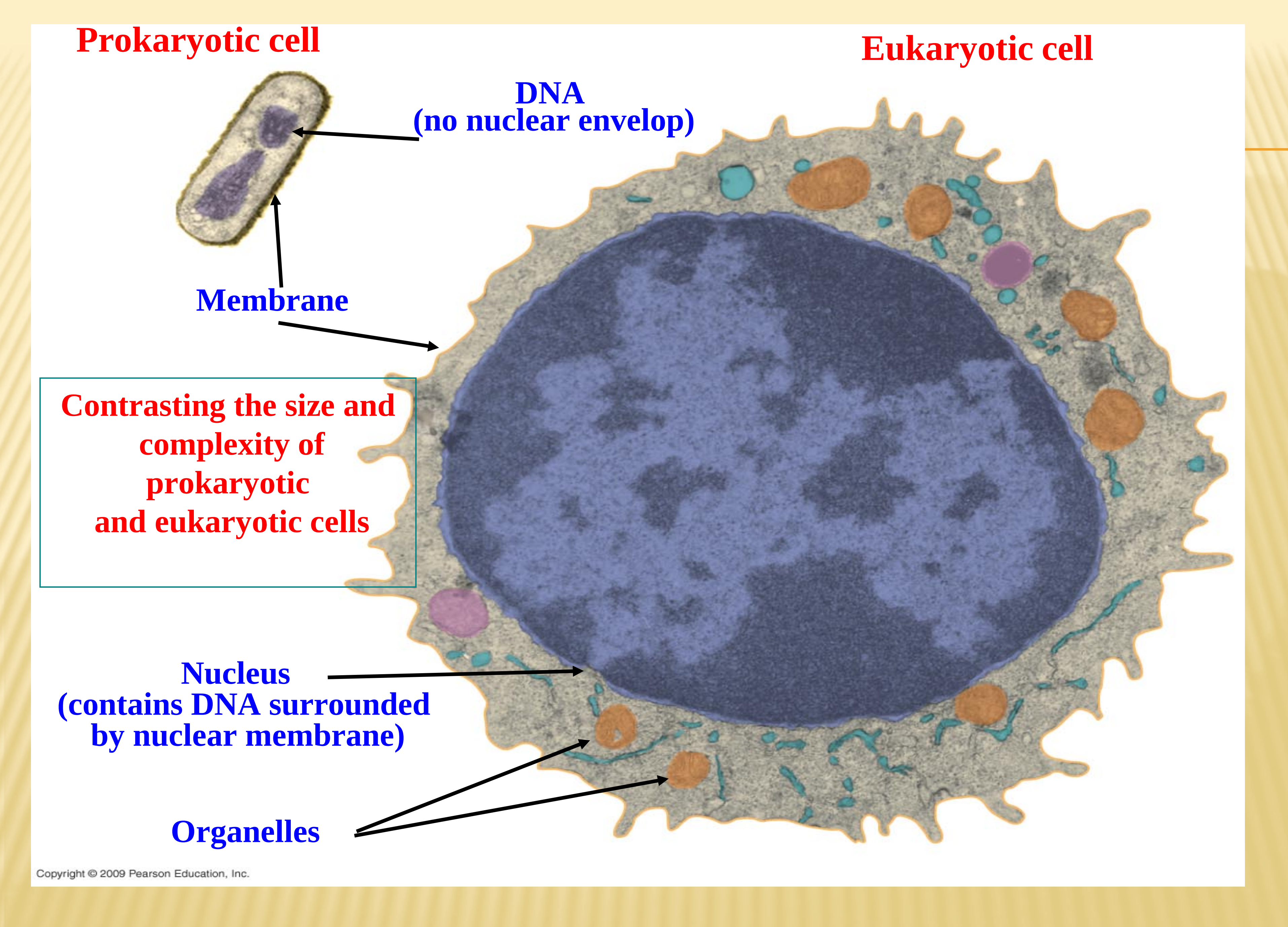
Cells are the structural and functional units of life

Prokaryotic cells

1) Genetic material is not surrounded by a nuclear membrane
2) Simple and small
3) No membrane-bound organelles
4) Single celled organisms.
5) Bacteria and Archaea

Eukaryotic cells

1) Genetic material is surrounded by a nuclear membrane
2) Possess organelles surrounded by membranes
3) Plants, animals, and fungi are eukaryotic


Prokaryotic cell
Eukaryotic cell
DNA
(no nuclear envelop)
Membrane
Contrasting the size and complexity of prokaryotic and eukaryotic cells
Nucleus
(contains DNA surrounded by nuclear membrane)
Organelles
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Prokaryotic cells are structurally simpler than eukaryotic cells

Bacteria and Archaea have prokaryotic cells

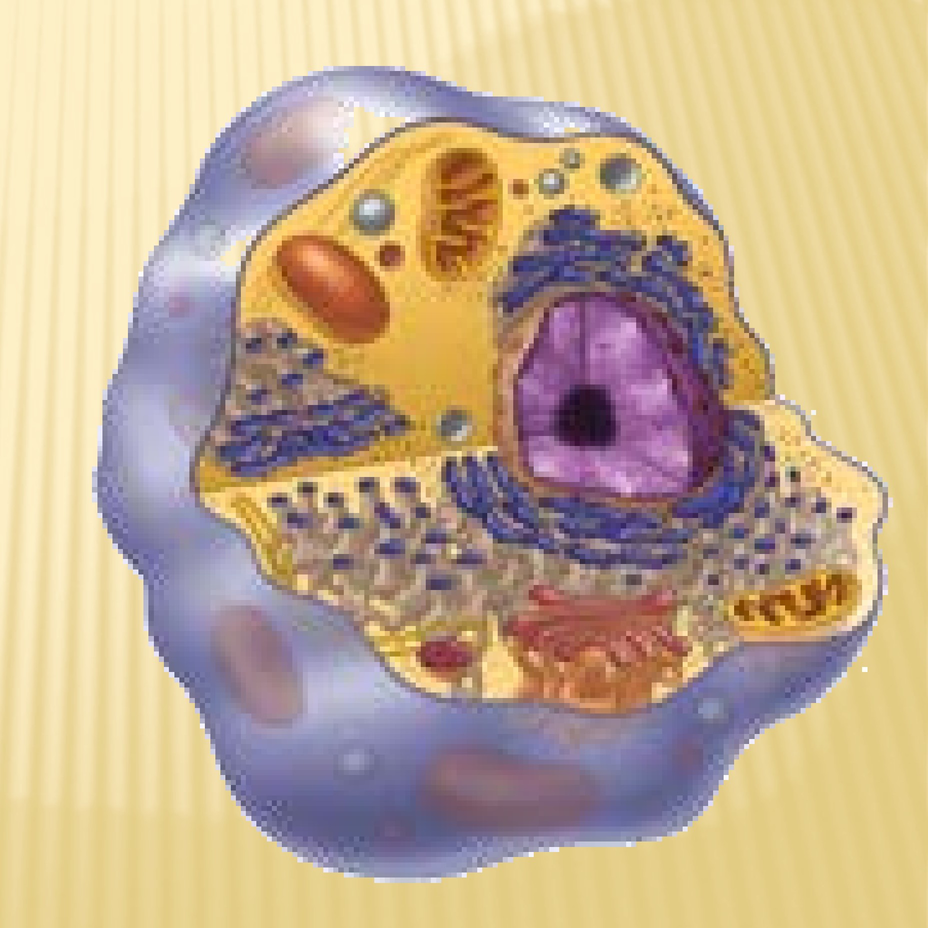
All other forms of life have eukaryotic cells

- **Both prokaryotic and eukaryotic cells have a plasma membrane and one or more chromosomes and ribosomes**
- **Eukaryotic cells have a membrane-bound nucleus and a number of other organelles, whereas prokaryotes have a nucleoid and no true organelles**

Eukaryotic Cell

Contains 3 basic cell structures:

1) **Nucleus**
2) **Cell Membrane**
3) **Cytoplasm with organelles**



Organelles

1) **Very small (Microscopic)**

2) **Perform various functions for a cell**

3) **Found in the cytoplasm**

4) **May or may not be membrane-bound**

Organelles Found in Cells

Examples of Organelles include:

1) **Endoplasmic reticulum (rough & smooth) Function in Synthesis of cell products & Transport**

2) **Golgi Bodies: wrap & export proteins**

3) **Nucleolus: makes ribosomes**

4) **Lysosomes: digest & get rid of wastes**

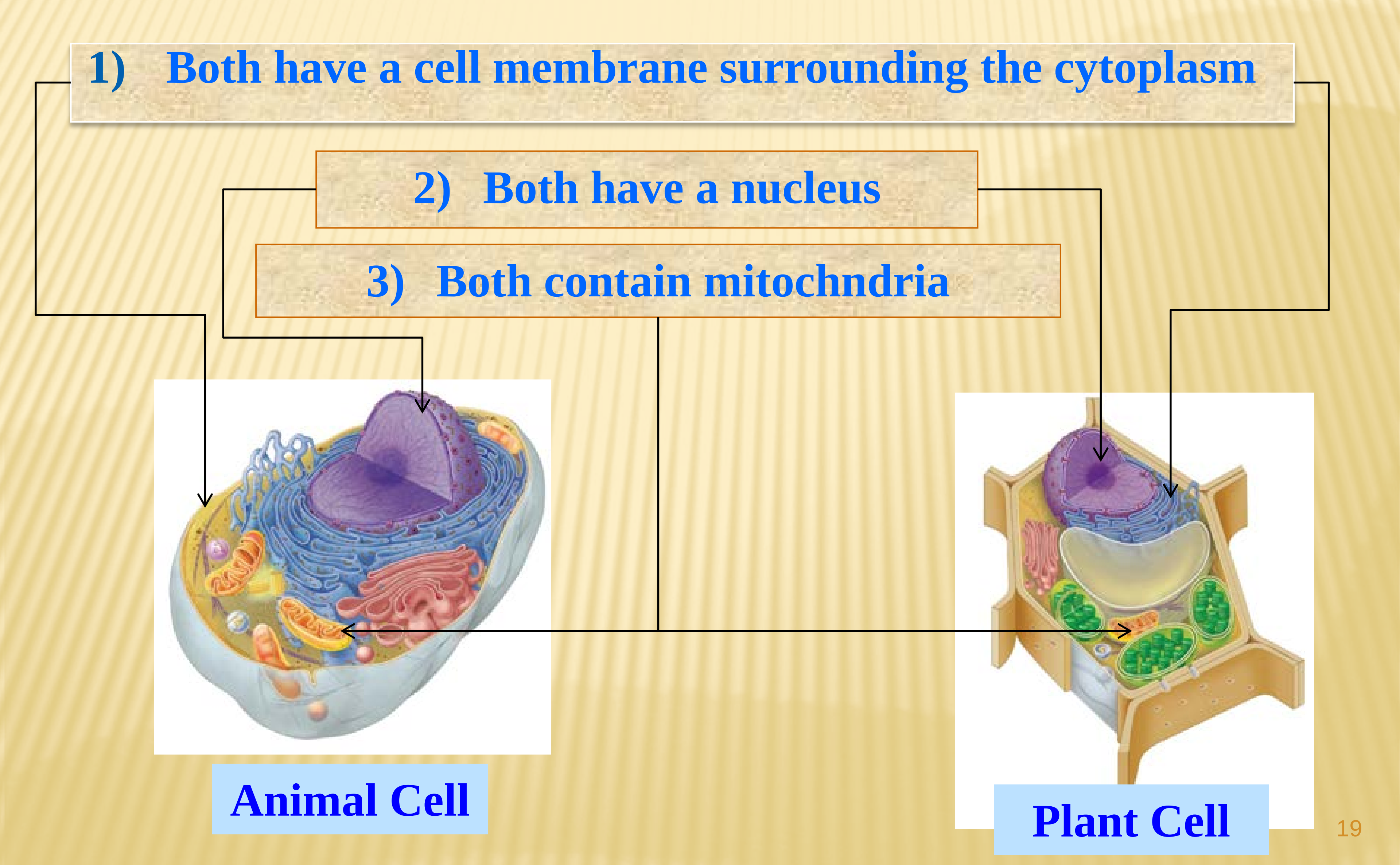
5) **Ribosomes: make proteins**

Eukaryotic cells

There are four life processes in eukaryotic cells that depend upon structures and organelles

1) **Manufacturing**
2) **Breakdown of molecules**
3) **Energy processing**
4) **Structural support, movement, and communication**

Similarities between plant cells and animal cells



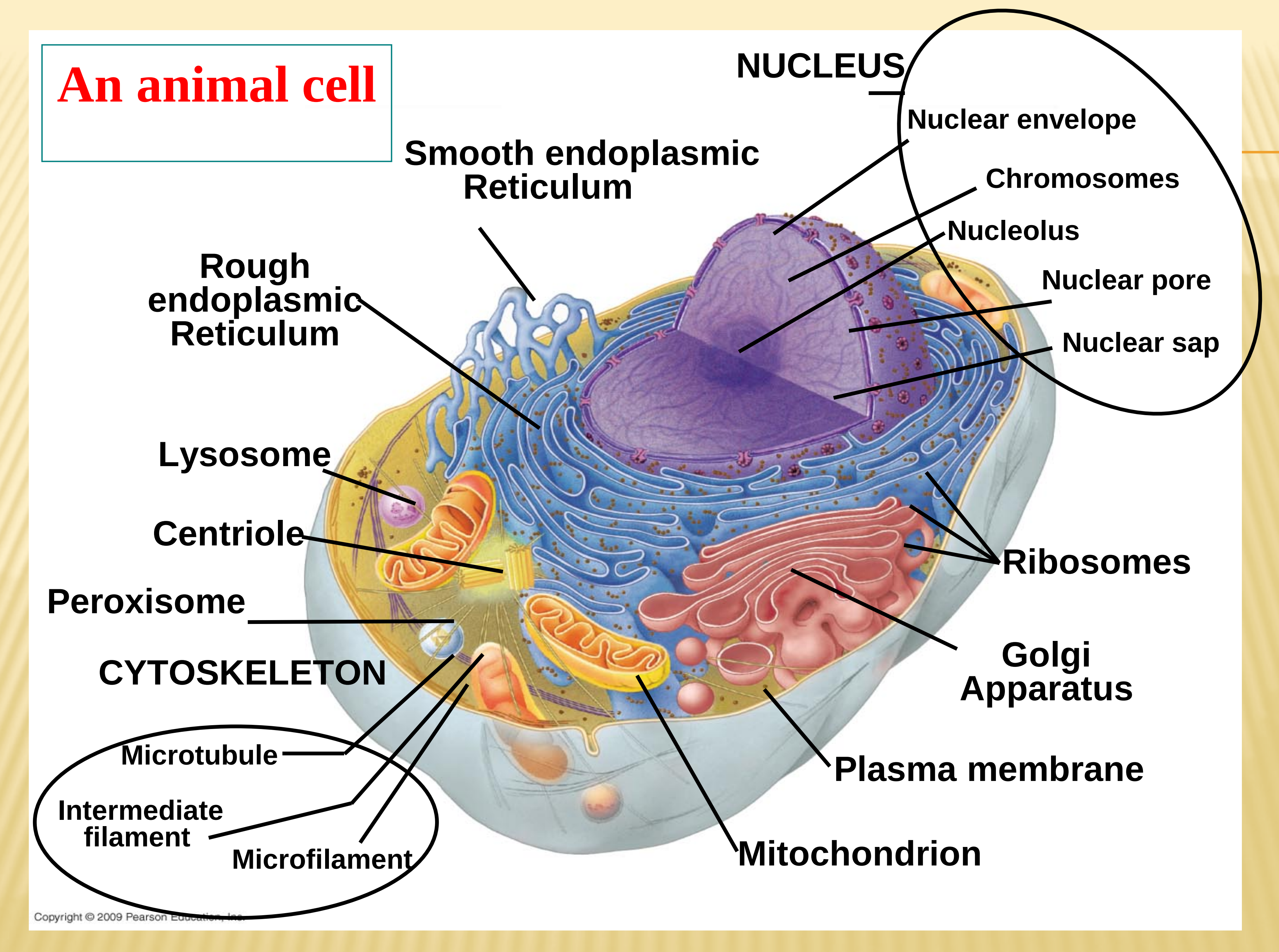
Differences between plant cells and animal cells

Although there are many similarities between animal and plant cells, differences exist

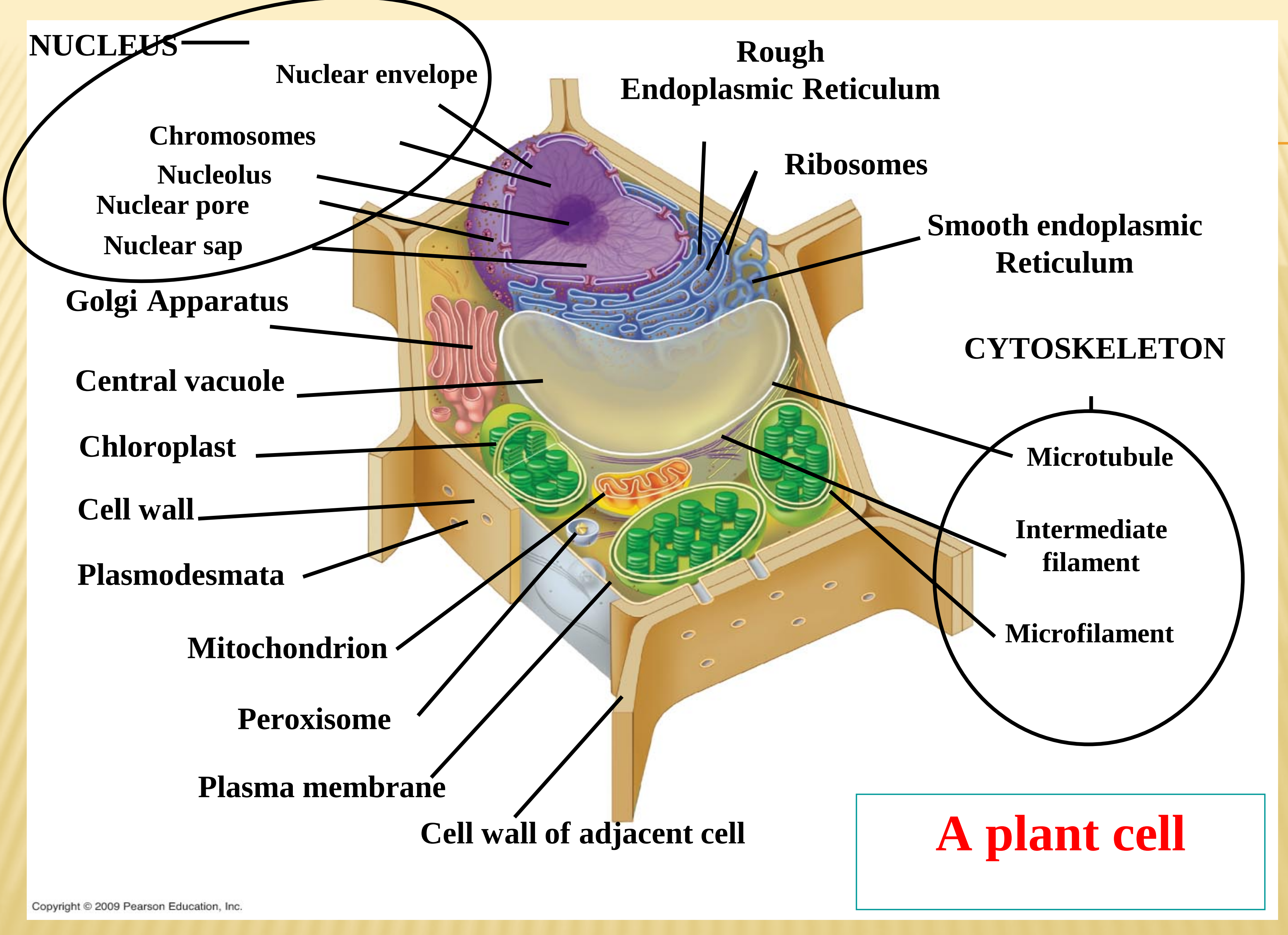
Animal cells	Plant cells
Relatively smaller in size	Relatively larger in size
Lysosomes and centrioles are found in animal cells	Lysosomes and centrioles are not found in plant cells
No cell wall, No chloroplasts	Cell wall and chloroplasts present

Differences between Plant Cells and Animal Cells

Animal cells	Plant cells
Vacuole small or absent	Large central vacuole
Glycogen as food storage	Starch as food storage
Nucleus at the center of the cell	Nucleus near cell wall



An animal cell
NUCLEUS
Nuclear envelope
Chromosomes
Nucleolus
Nuclear pore
Nuclear sap
Smooth endoplasmic Reticulum
Rough endoplasmic Reticulum
Lysosome
Centriole
Peroxisome
CYTOSKELETON
Microtubule
Intermediate filament
Microfilament
Ribosomes
Golgi Apparatus
Plasma membrane
Mitochondrion
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NUCLEUS
Nuclear envelope
Chromosomes
Nucleolus
Nuclear pore
Nuclear sap
Rough Endoplasmic Reticulum
Ribosomes
Smooth endoplasmic Reticulum
Golgi Apparatus
Central vacuole
Chloroplast
Cell wall
Plasmodesmata
Mitochondrion
Peroxisome
Plasma membrane
Cell wall of adjacent cell
CYTOSKELETON
Microtubule
Intermediate filament
Microfilament
A plant cell
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Cell Structures

1. Plasma membrane
2. Cytoplasm
3. Nucleus
4. Ribosomes
5. Endoplasmic Reticulum – ER
6. Golgi apparatus
7. Lysosomes
8. Vacuoles
9. Endomembrane System
10. Mitochondria
11. Chloroplasts
12. Cytoskeleton
13. Cilia and flagella
14. Extracellular matrix (ECM)
15. Cell junctions

The structure of plasma membranes

The plasma membrane controls the movement of molecules into and out of the cell, a trait called

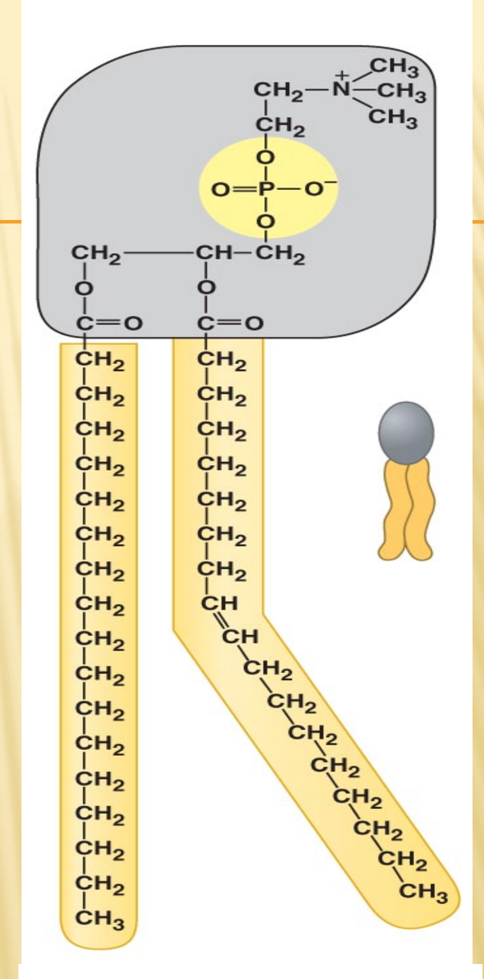
Selective Permeability

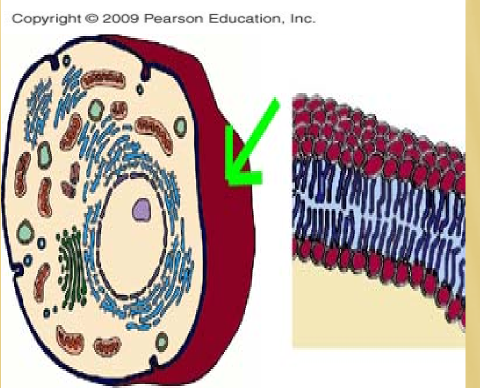
The structure of the membrane with its component molecules is responsible for this characteristic

Membranes are made of lipids, proteins, and some carbohydrates, but the most abundant lipids are phospholipids

Phospholipids

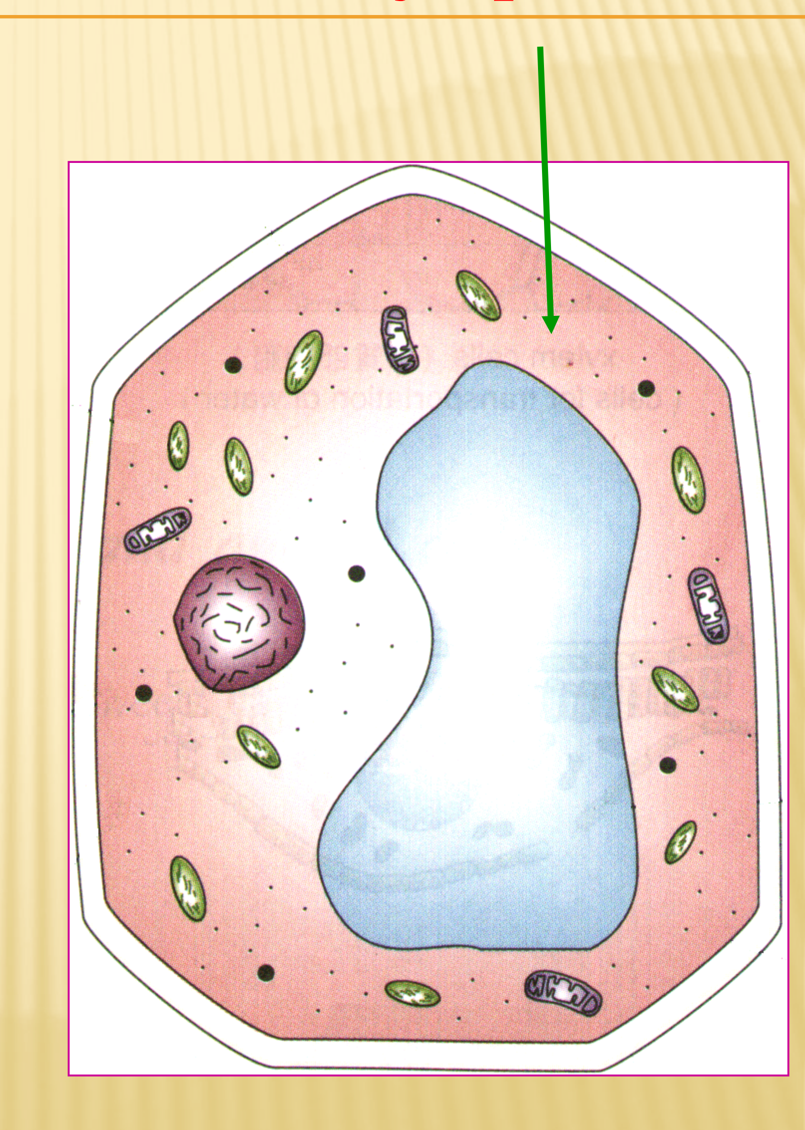
- **Heads contain glycerol & phosphate and are hydrophilic (attract water)**
- **Tails are made of fatty acids and are hydrophobic (repel water)**
- **Make up a bilayer where tails point inward toward each other**
- **Can move laterally to allow small molecules (O_2, CO_2, & H_2O to enter)**





Cytoplasm of a Cell

- Jelly-like substance enclosed by cell membrane
- Provides a medium for chemical reactions to take place
- Contains organelles to carry out specific jobs
- Found in ALL cells



The Control Organelle (The Nucleus)

- **Controls the normal activities of the cell**
- **Contains the DNA in chromosomes**
- **Bounded by a nuclear envelope (membrane) with pores**
- **Usually the largest organelle**

Nucleus

Ribosomes

- Made of Proteins and rRNA

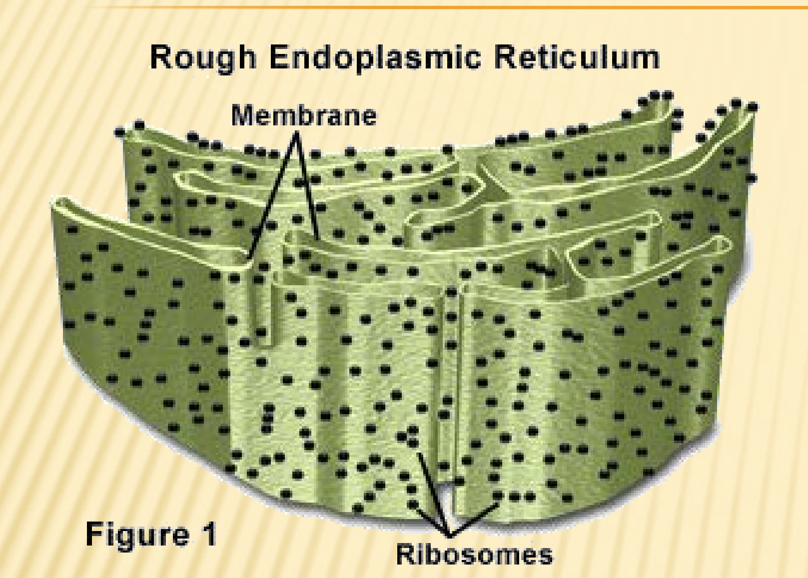
- Ribosomes are synthesized in the nucleolus, which is found in the nucleus

- "Protein factories" for cell

- Join amino acids to make proteins, Process called protein synthesis

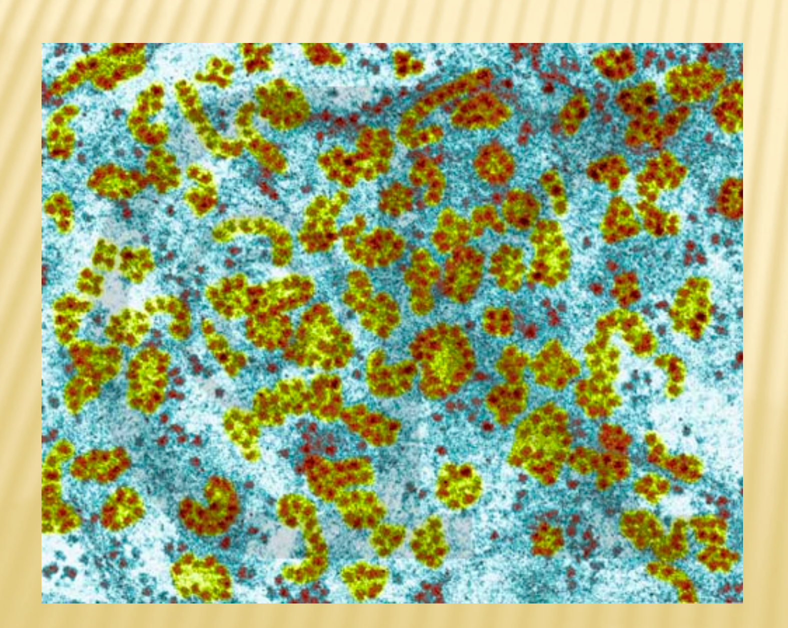
- Cells that synthesize large amounts of protein have a large number of ribosomes

Ribosomes

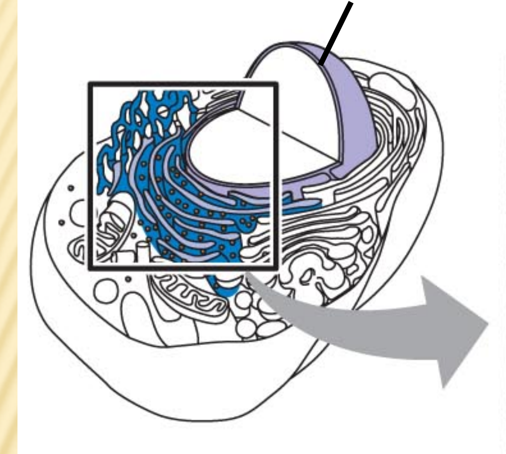


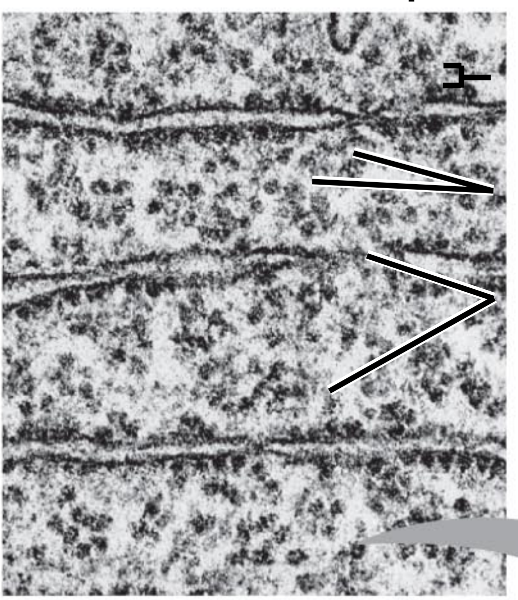
Can be attached to endoplasmic reticulum ER & makes proteins to export





Be free (unattached) in the cytoplasm & makes proteins USED In the cell





Cytoplasm

Endoplasmic reticulum (ER)

Free ribosomes

Bound ribosomes

Large subunit

Small subunit

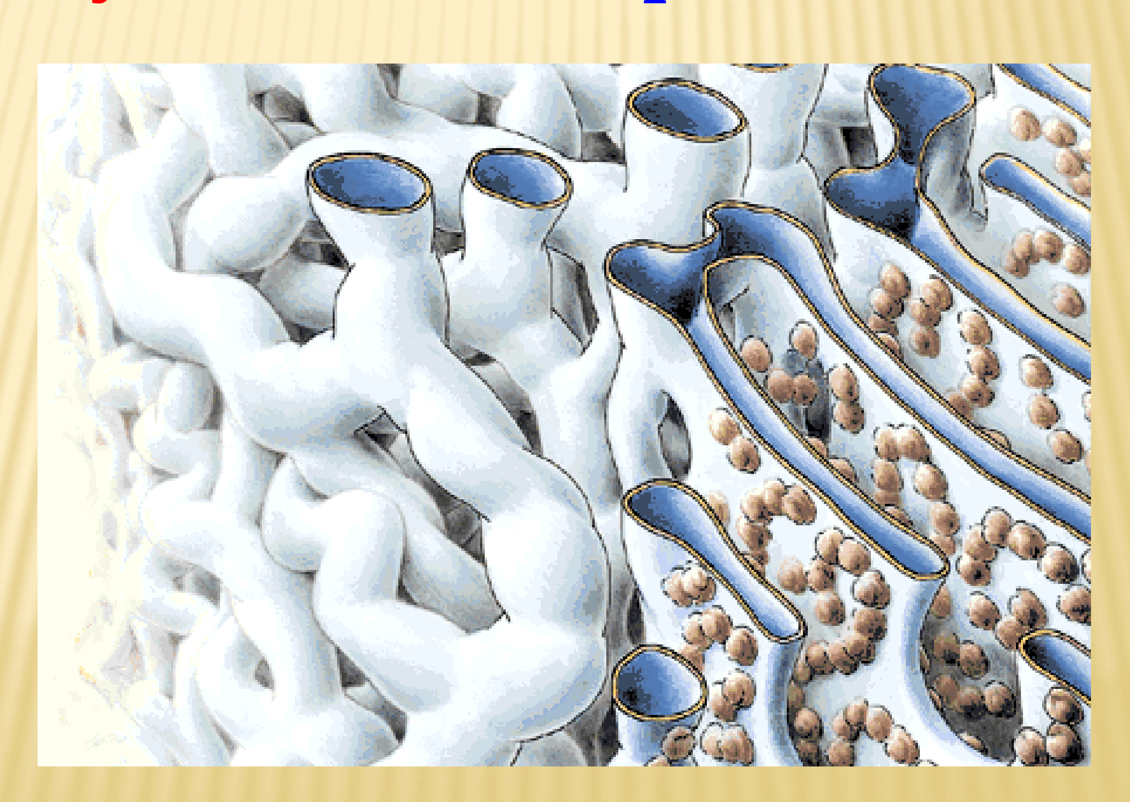
TEM showing ER and ribosomes

Diagram of a ribosome

Ribosomes

Endoplasmic Reticulum - ER

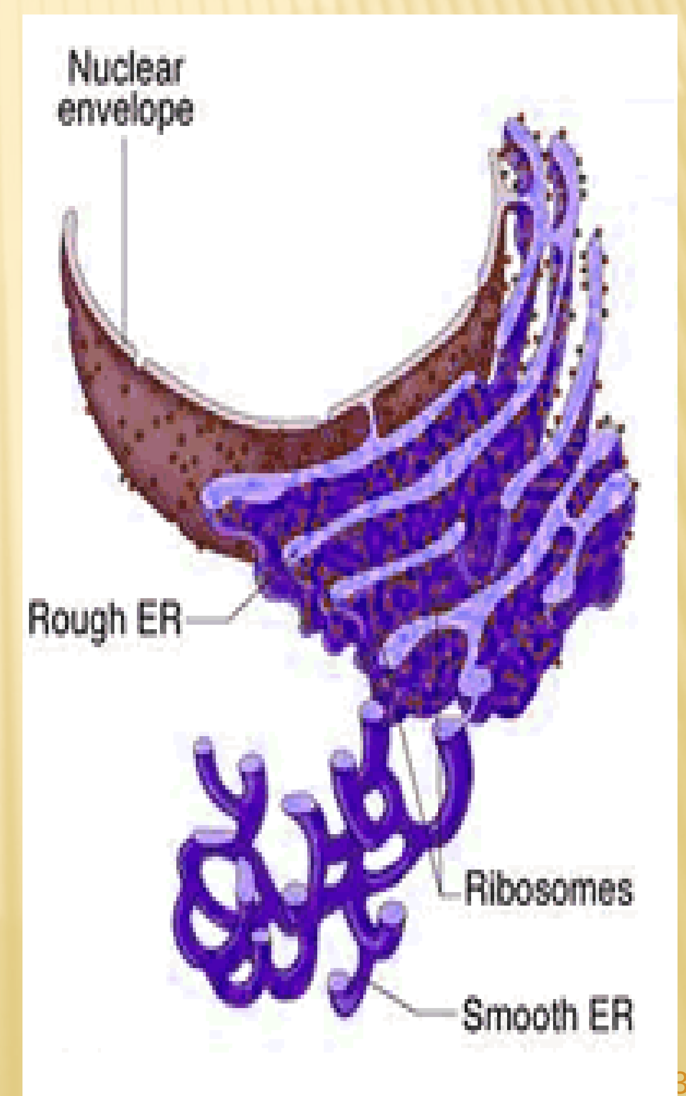
- Network of hollow membrane tubules
- Connect to nuclear envelope & cell membrane
- Function in Synthesis of cell products & Transport

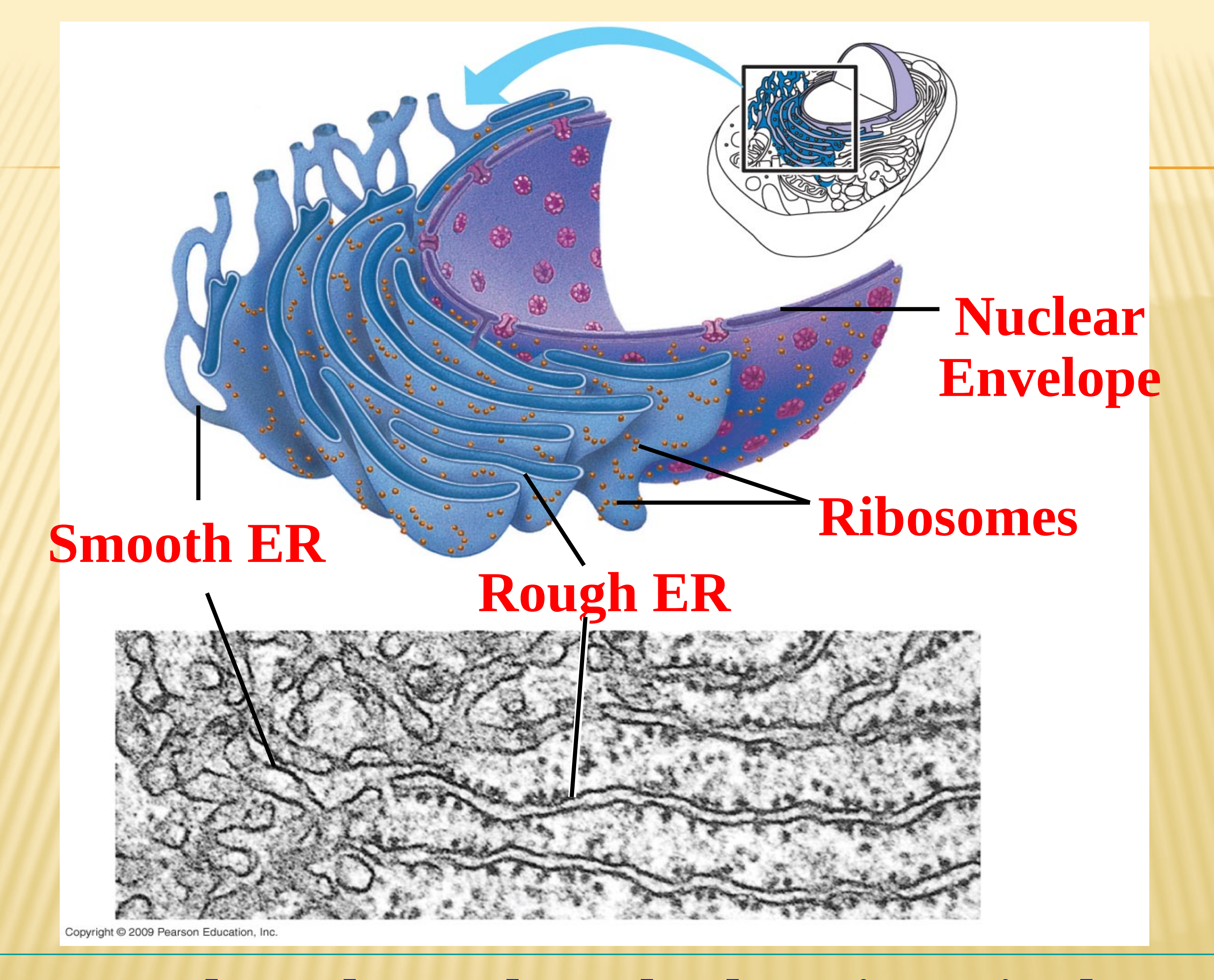


The endoplasmic reticulum

Smooth & Rough Endoplasmic Reticulum

- **There are two kinds of endoplasmic reticulum - smooth and rough**
- ***Smooth ER*** **lacks ribosomes**
- ***Rough ER*** **has ribosomes on its surface**





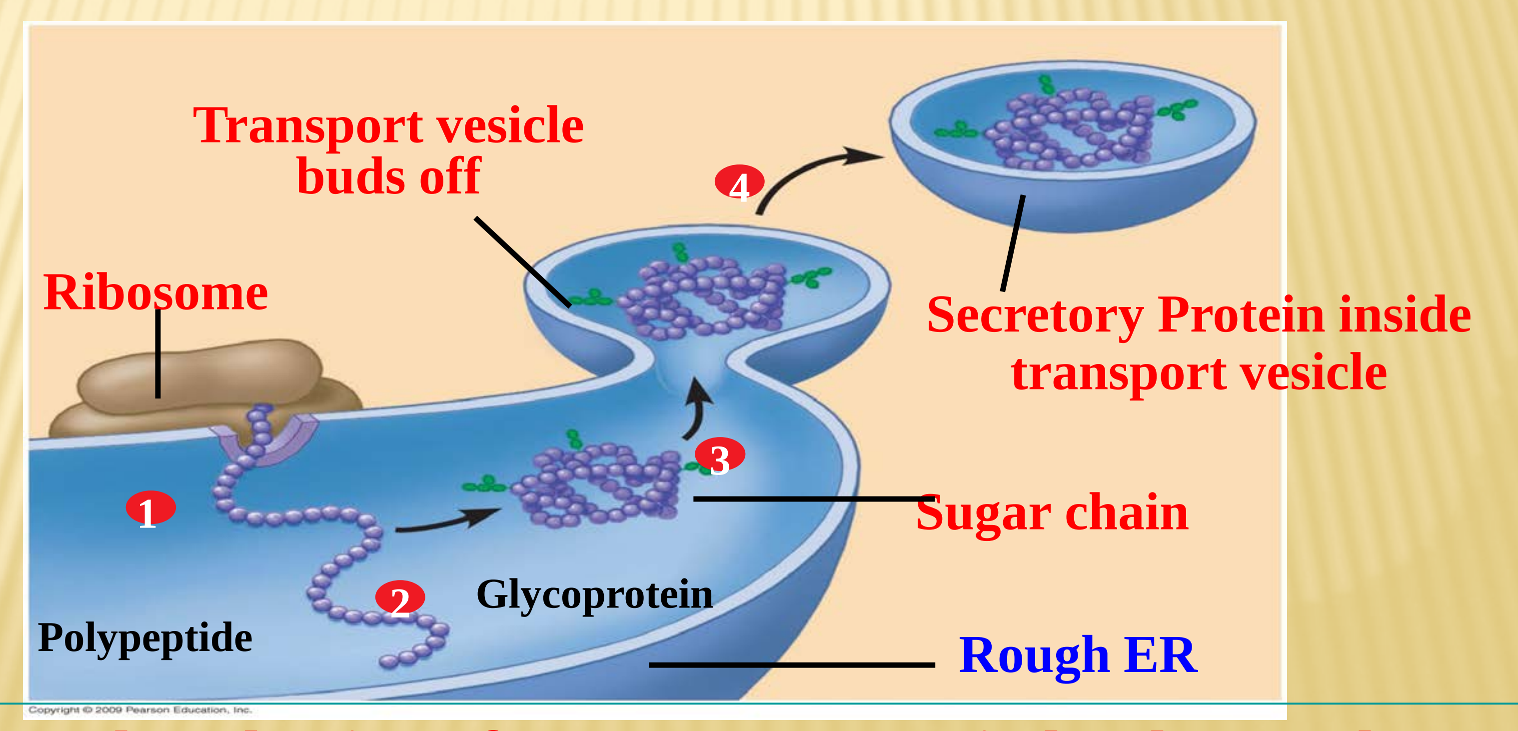
Smooth and rough endoplasmic reticulum

The Smooth Endoplasmic Reticulum SER

- **Smooth ER is involved in a variety of diverse metabolic processes**
  - **For example, enzymes of the smooth ER are involved in the synthesis of**
    - **Lipids**
    - **Oils**
    - **Phospholipids**
    - **Steroids and destroys toxic substances (liver)**

The Rough Endoplasmic Reticulum RER

- Rough ER makes additional membrane for itself and proteins destined for secretion
- Once proteins are synthesized by ribosomes attached to ER, they are modified in the ER lumen then transported in vesicles to other parts of the endomembrane system

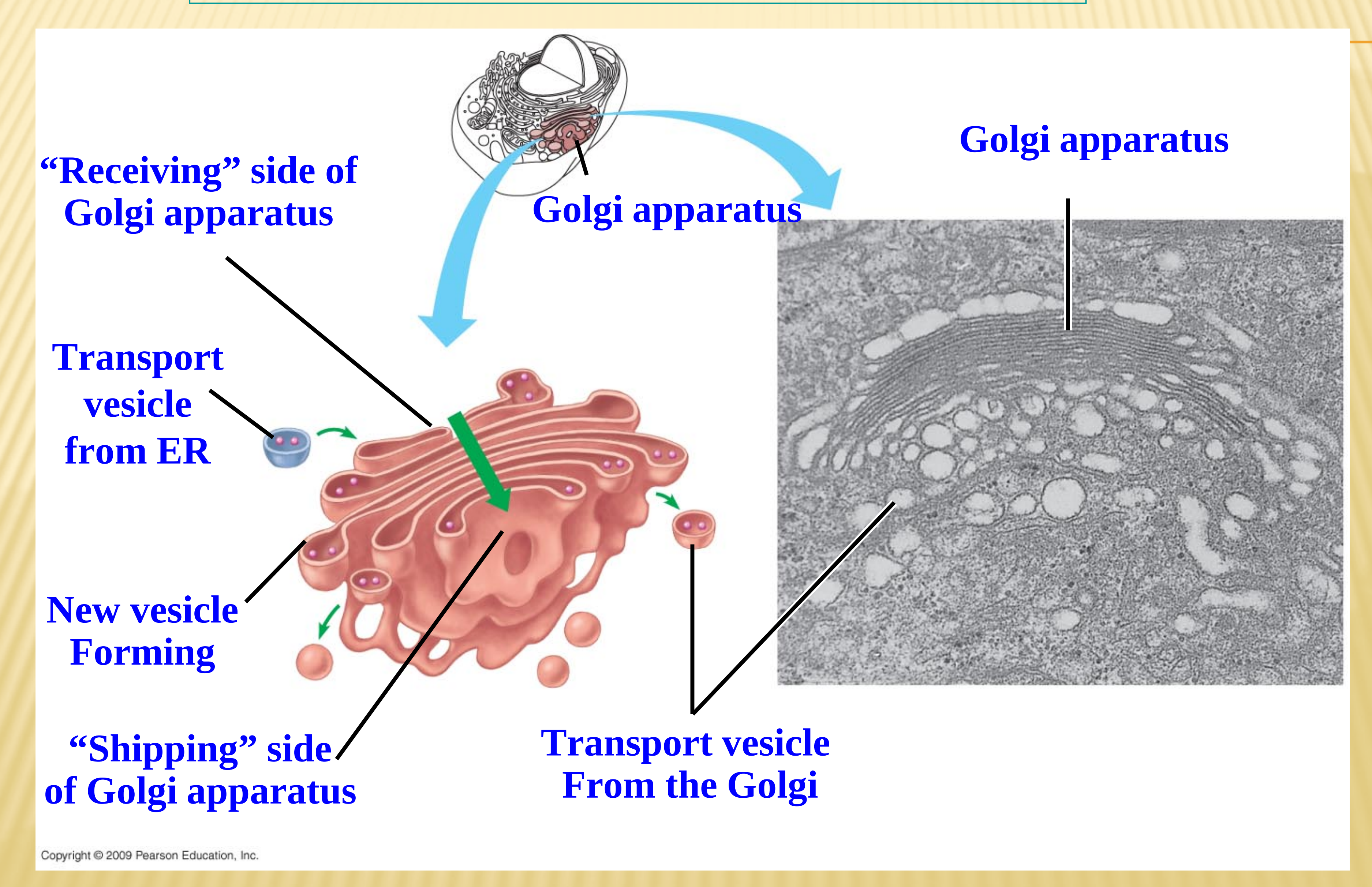


Synthesis and packaging of a secretory protein by the rough ER

The Golgi apparatus

- The Golgi apparatus is Stacks of flattened sacs
- Functions in conjunction with the ER
- Receive & modify proteins made by ER
  - Products travel in transport vesicles from the ER to the Golgi apparatus
  - Products are modified as they go from one side of the Golgi apparatus to the other and travel in vesicles to other sites

The Golgi apparatus

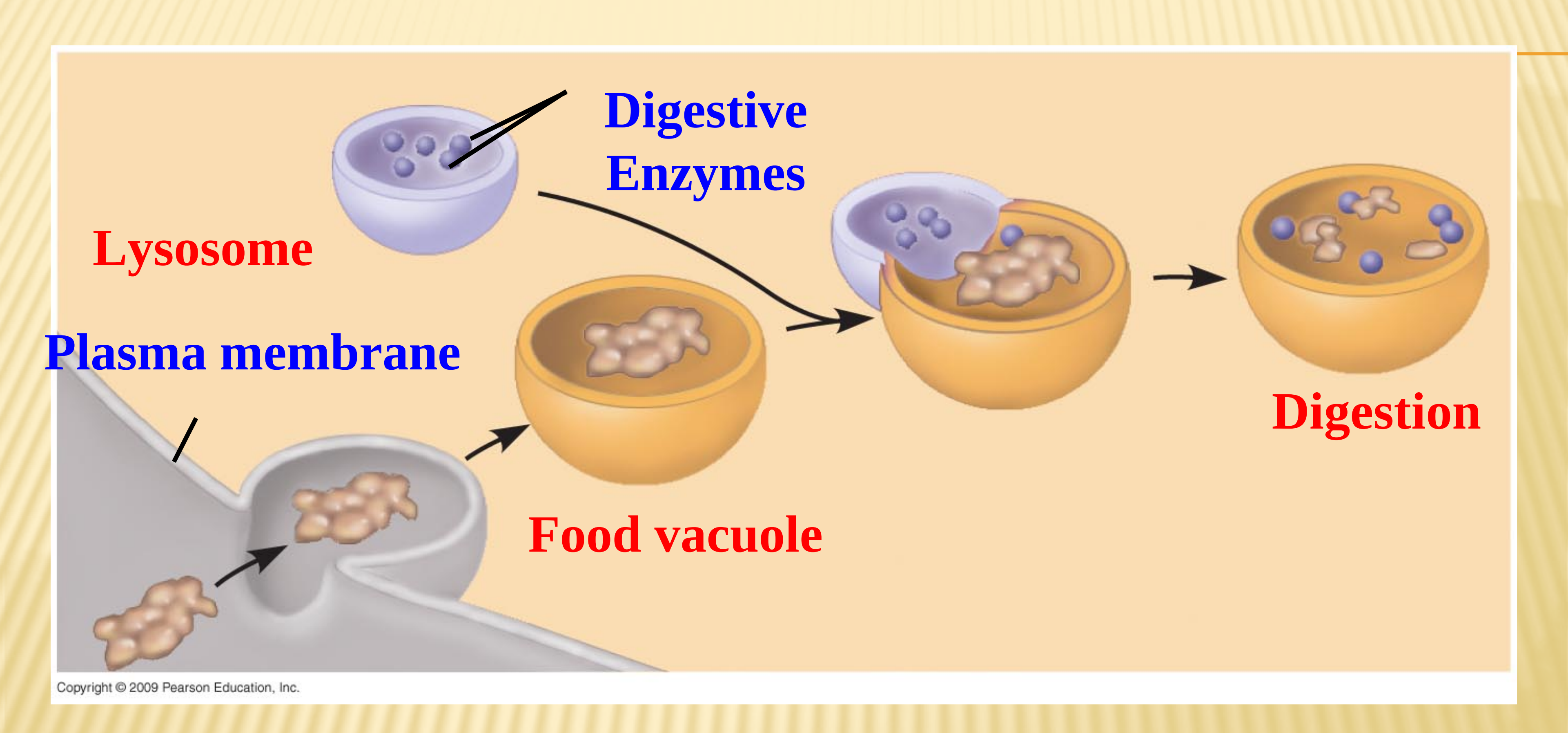


Lysosomes

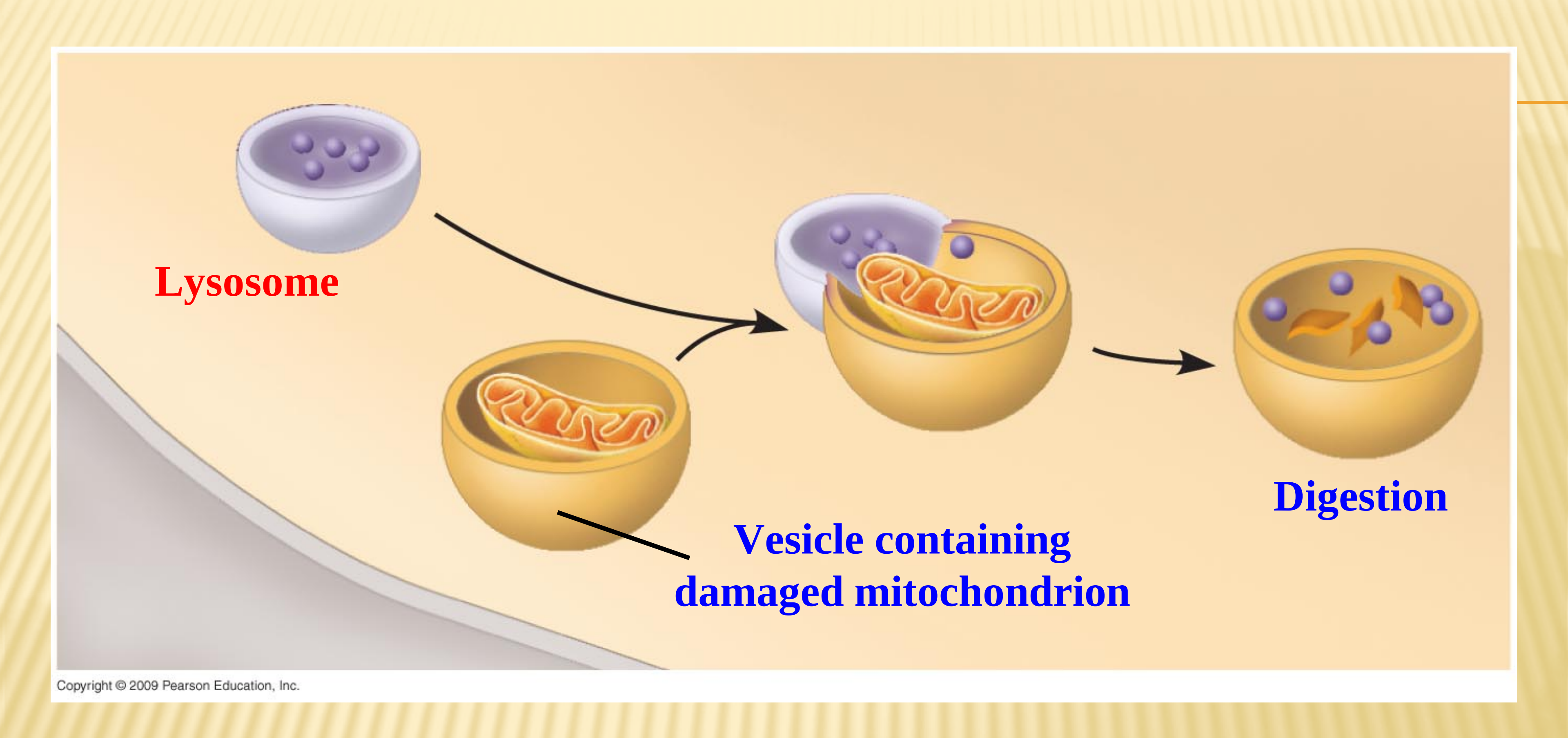
- **A lysosome is a membranous sac;**
- **Contains digestive enzymes**
- **Breaks down food, bacteria, and worn out cell parts**
- **Breaks down and recycles cell parts**

Lysosomes are digestive compartments

- **The enzymes and membrane are produced by the ER and transferred to the Golgi apparatus for processing**
- **The membrane serves to safely isolate these potent enzymes from the rest of the cell**
- **One of the several functions of lysosomes is to remove or recycle damaged parts of a cell**
  - **The damaged organelle is first enclosed in a membrane vesicle**
  - **Then a lysosome fuses with the vesicle, dismantling its contents and breaking down the damaged organelle**



Lysosome fusing with a food vacuole and digesting food

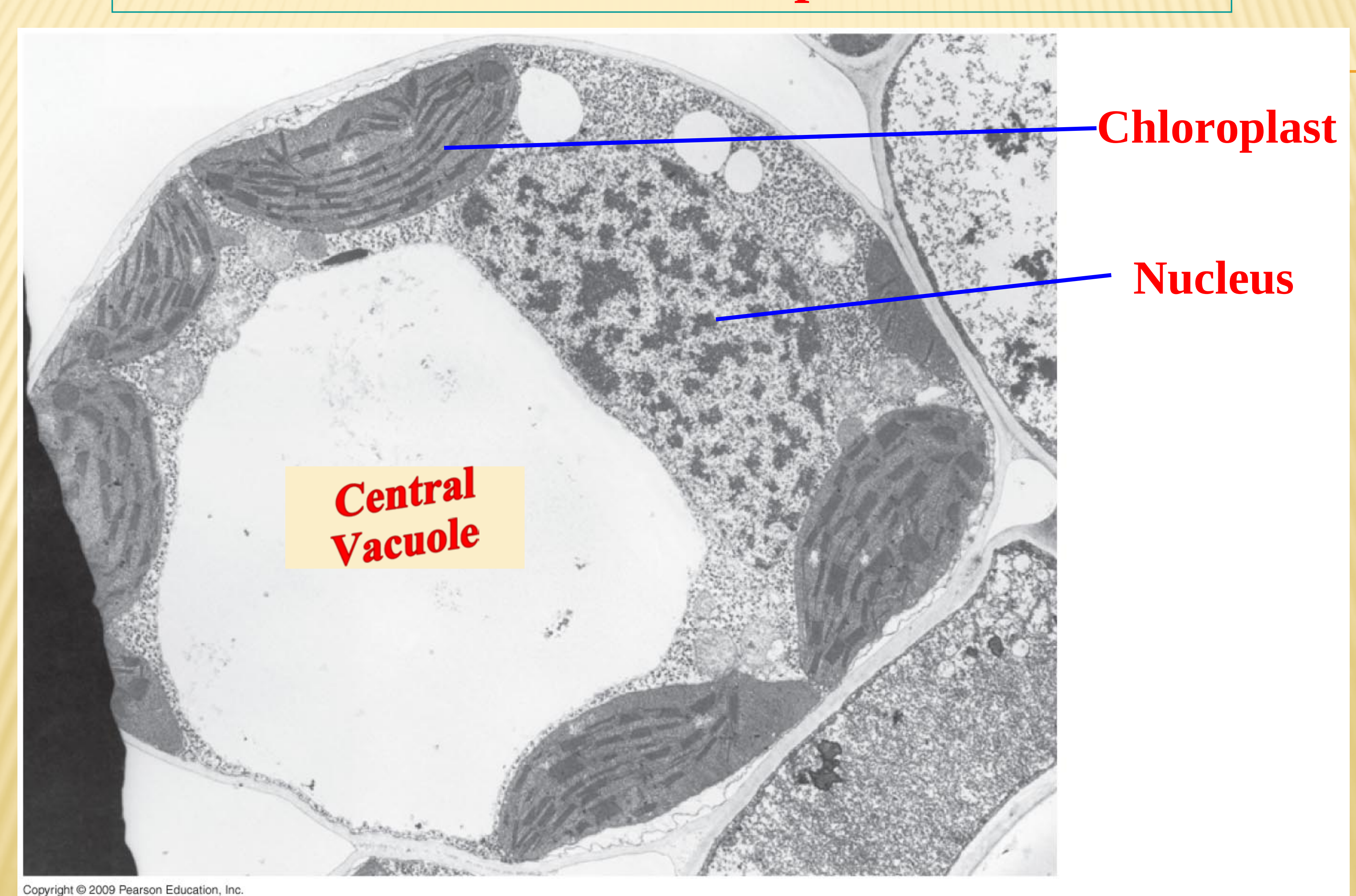


Lysosome fusing with vesicle containing damaged organelle and digesting and recycling its contents

Vacuoles

- **Vacuoles are membranous sacs that are found in a variety of cells and possess an assortment of functions**
  - **Examples are the central vacuole in plants with hydrolytic functions**
  - **Pigment vacuoles in plants to provide color to flowers**
  - **Contractile vacuoles in some protists to expel water from the cell**

Central vacuole in a plant cell

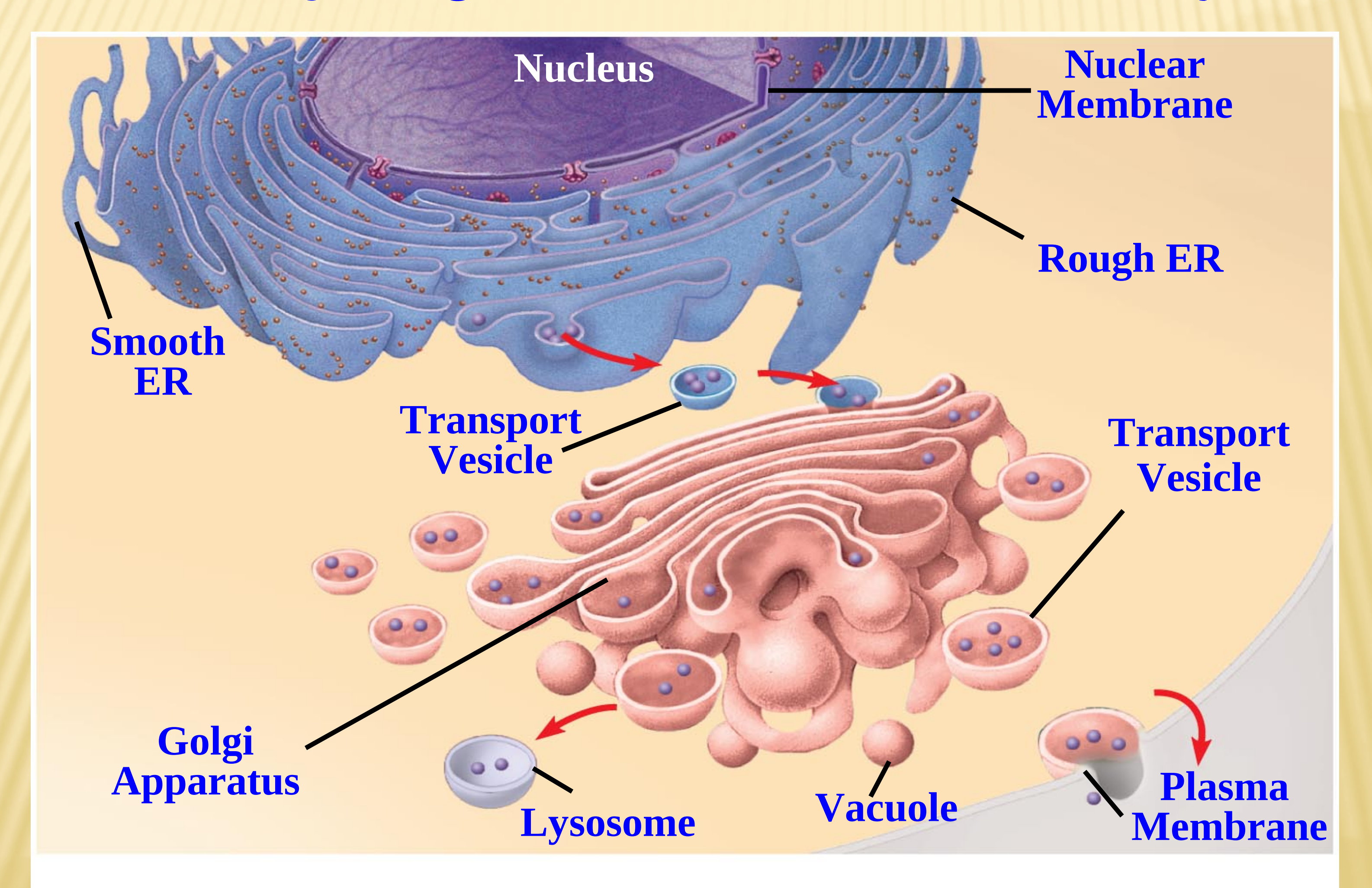


Endomembrane System

- **The membranes within an Eukaryotic cell are physically connected directly or indirectly and compose the endomembrane system**
- **The endomembrane system includes**
  1. **The nuclear membrane (envelope),**
  2. **Endoplasmic reticulum (ER),**
  3. **Golgi apparatus,**
  4. **Lysosomes**
  5. **Vacuoles, and**
  6. **The plasma membrane**

Endomembrane System

The following figure summarizes the relationships among the major organelles of the endomembrane system



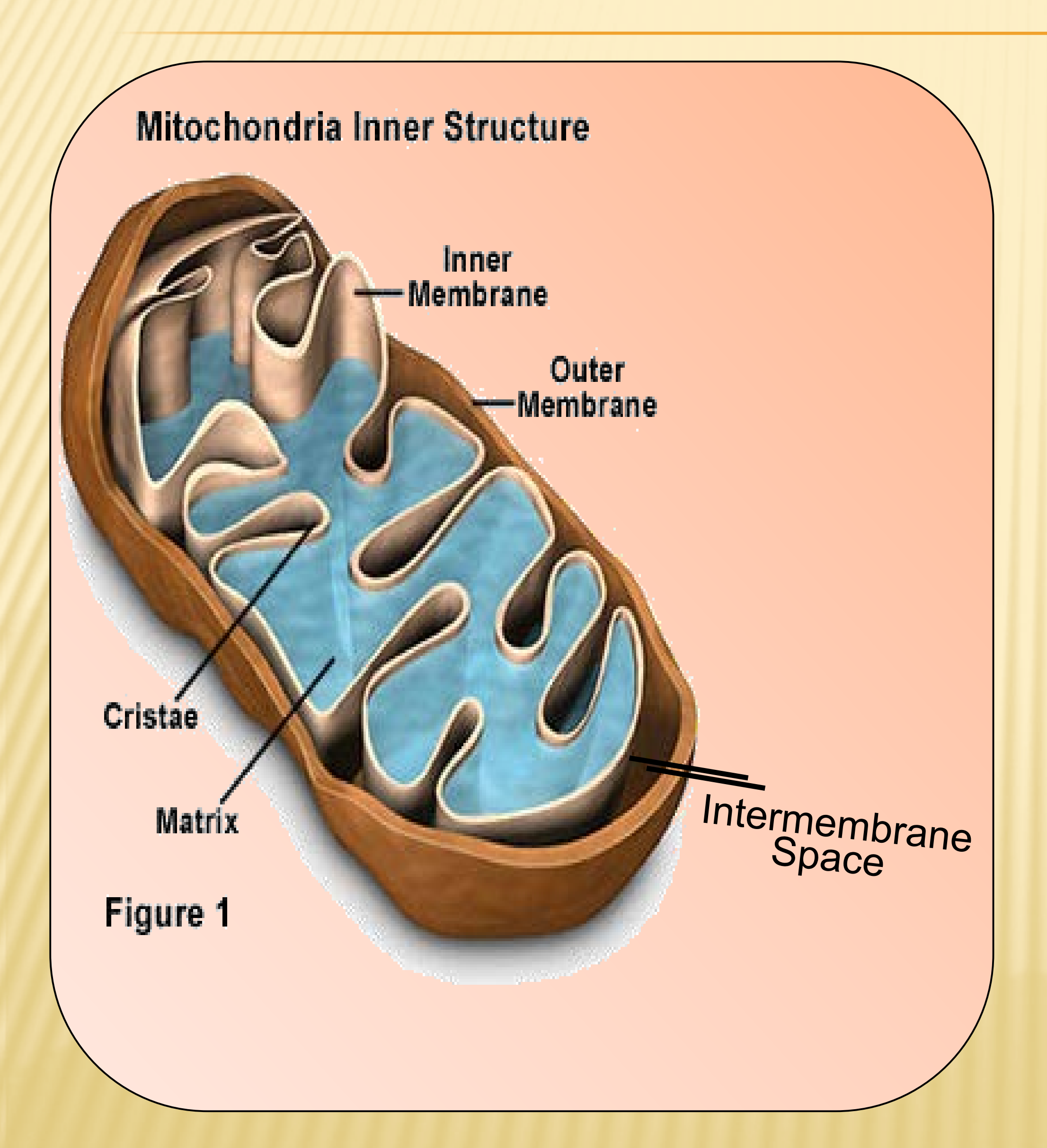
Connections among the organelles of the endomembrane system

Mitochondria

- **"Powerhouse" of the cell**
- **Generate cellular energy** (adenosine triphosphate) **(ATP)**
- **More active cells like muscle cells have more mitochondria**
- **Both plants & animal cells have mitochondria**
- **Site of cellular respiration (burning glucose)**



Mitochondria



Surrounded by a DOUBLE membrane

Has its own DNA

Folded inner membrane called cristae (increases surface area for more chemical Reactions)

Interior called matrix

Mitochondria harvest chemical energy from food

- **Cellular respiration is accomplished in the mitochondria of eukaryotic cells**
  - **Cellular respiration involves conversion of chemical energy in foods to chemical energy stored in ATP (adenosine triphosphate)**
  - **Mitochondria have two internal compartments**
  - **The intermembrane space, which encloses the mitochondrial matrix where materials necessary for ATP generation are found**

Chloroplasts

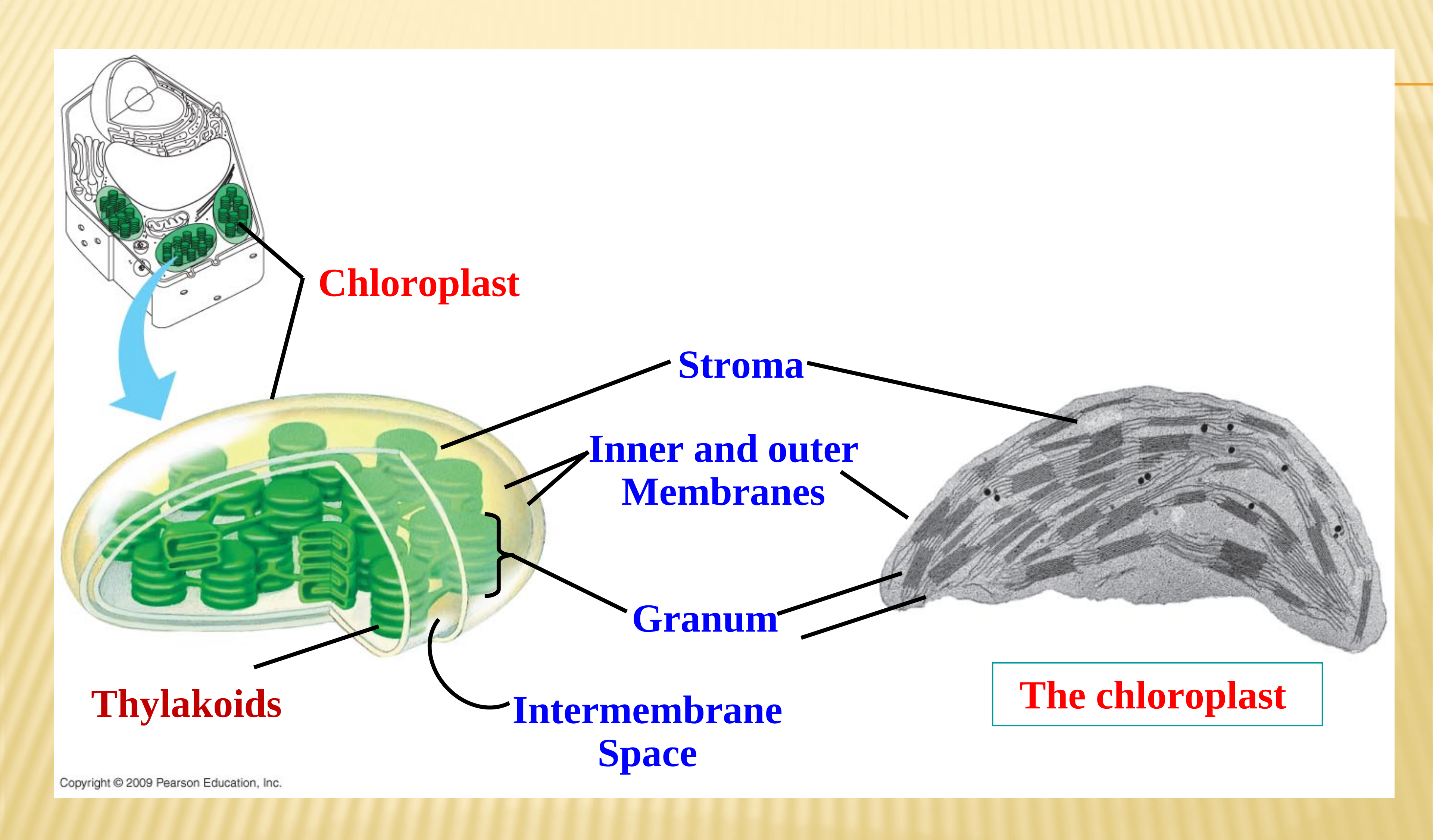
- **Found only in producers (organisms containing chlorophyll) like plants**
- **Producers use energy from sunlight to make their own food (Glucose)**
- **Energy from sun stored in the Chemical Bonds of Sugars**

Chloroplasts

- **Surrounded by DOUBLE membrane**
- **OUTER & INNER membrane**
- **Thylakoids in Stacks Called GRANA & interconnected**
- **STROMA – are gel-like material surrounding thylakoids**

Chloroplasts

- **Contains its own DNA**
- **Contains enzymes & pigments for Photosynthesis**
- **Never found in animal or bacterial cells**
- **Photosynthesis – food making process**


Chloroplast
Stroma
Inner and outer
Membranes
Granum
Thylakoids
Intermembrane
Space
The chloroplast
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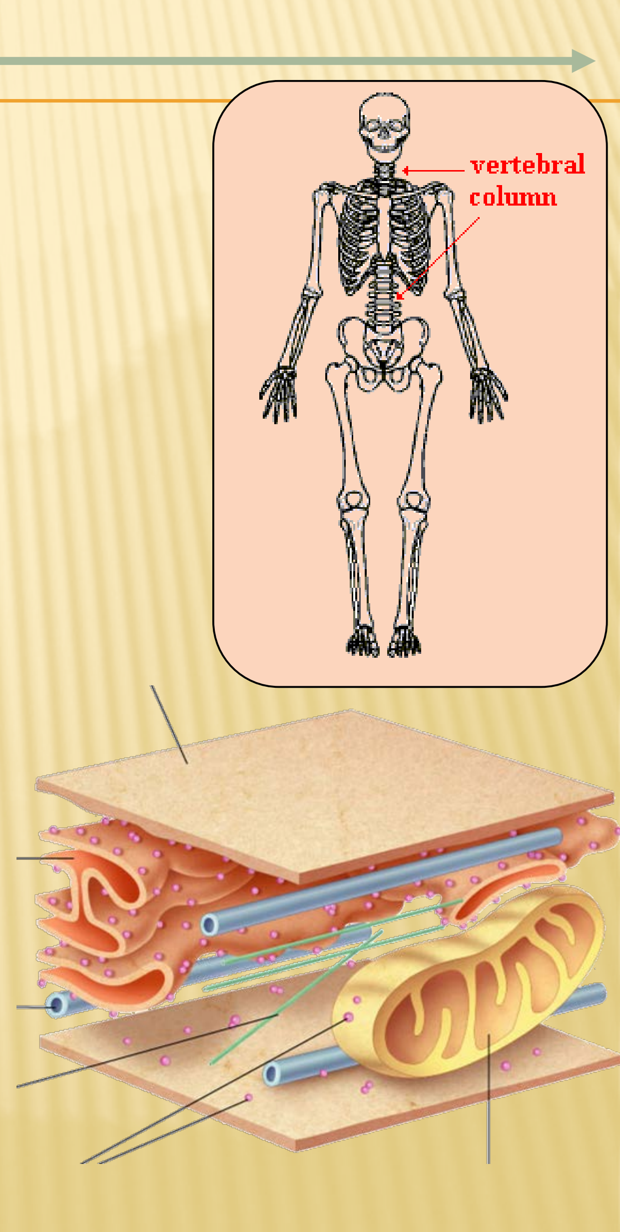
INTERNAL AND EXTERNAL SUPPORT:

THE CYTOSKELETON AND CELL SURFACES

Cytoskeleton

❖ **Cells contain a network of protein fibers, called the cytoskeleton, that functions in**

- **Helps cell maintain cell shape**
- **Also, helps move organelles around**

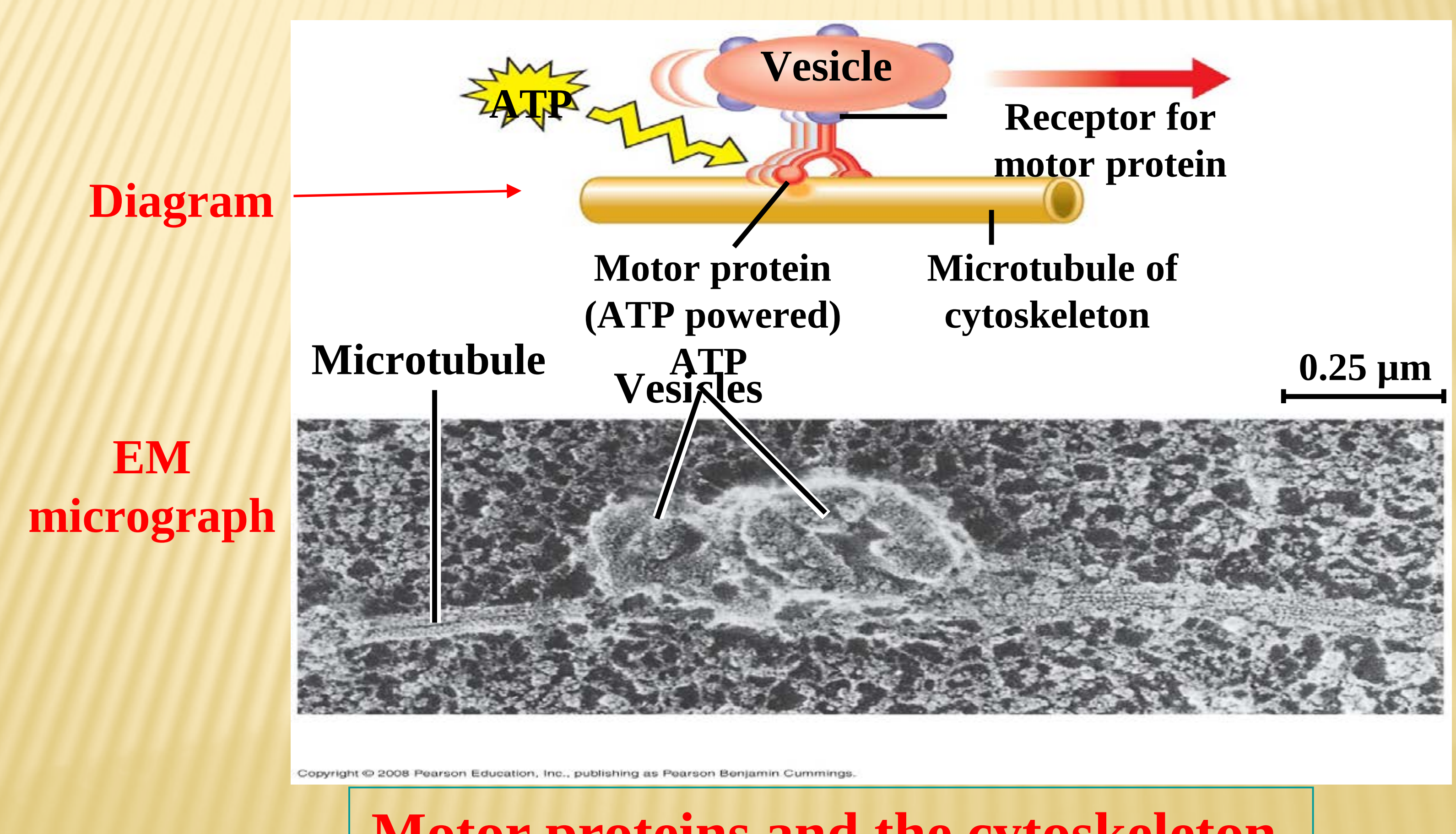


The cell's internal skeleton

- **The cytoskeleton is composed of three kinds of fibers**
  - **Microfilaments (*actin filaments*) support the cell's shape and are involved in motility made of *ACTIN***
  - **Intermediate filaments reinforce cell shape and anchor organelles**
  - **Microtubules (made of *TUBULIN*) shape the cell and act as tracks for motor protein**

The cell's internal skeleton

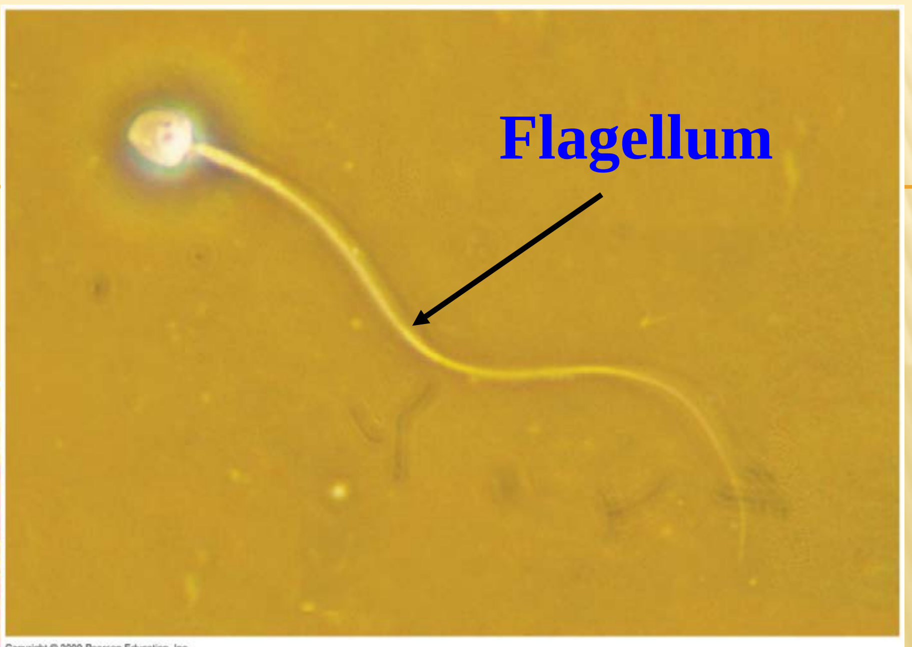
Motility and cellular regulation result when the cytoskeleton interacts with proteins called motor proteins



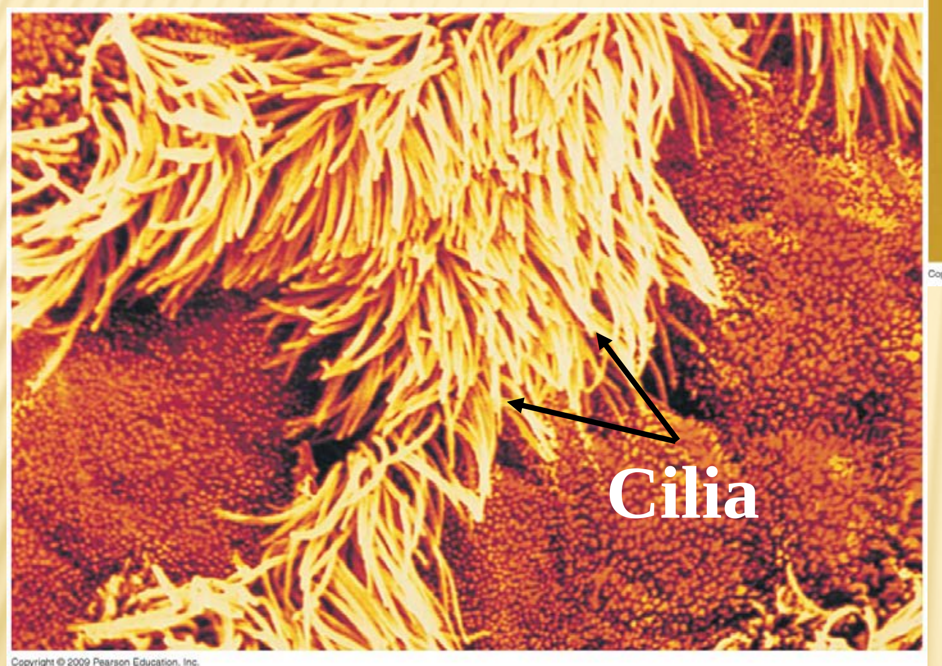
Motor proteins and the cytoskeleton

Cilia and flagella

- **Cilia and flagella are important in locomotion,**
- **Some cells of multicellular organisms have them for different reasons**
- **Cells that sweep mucus out of our trachea have cilia**
- **Animal sperm are flagellated**
- **Flagella and cilia are composed of microtubules**
- **They move when microtubules bend**



Undulating flagellum on a sperm cell



Cilia on cells lining the respiratory tract

Cilia and flagella move when microtubules bend

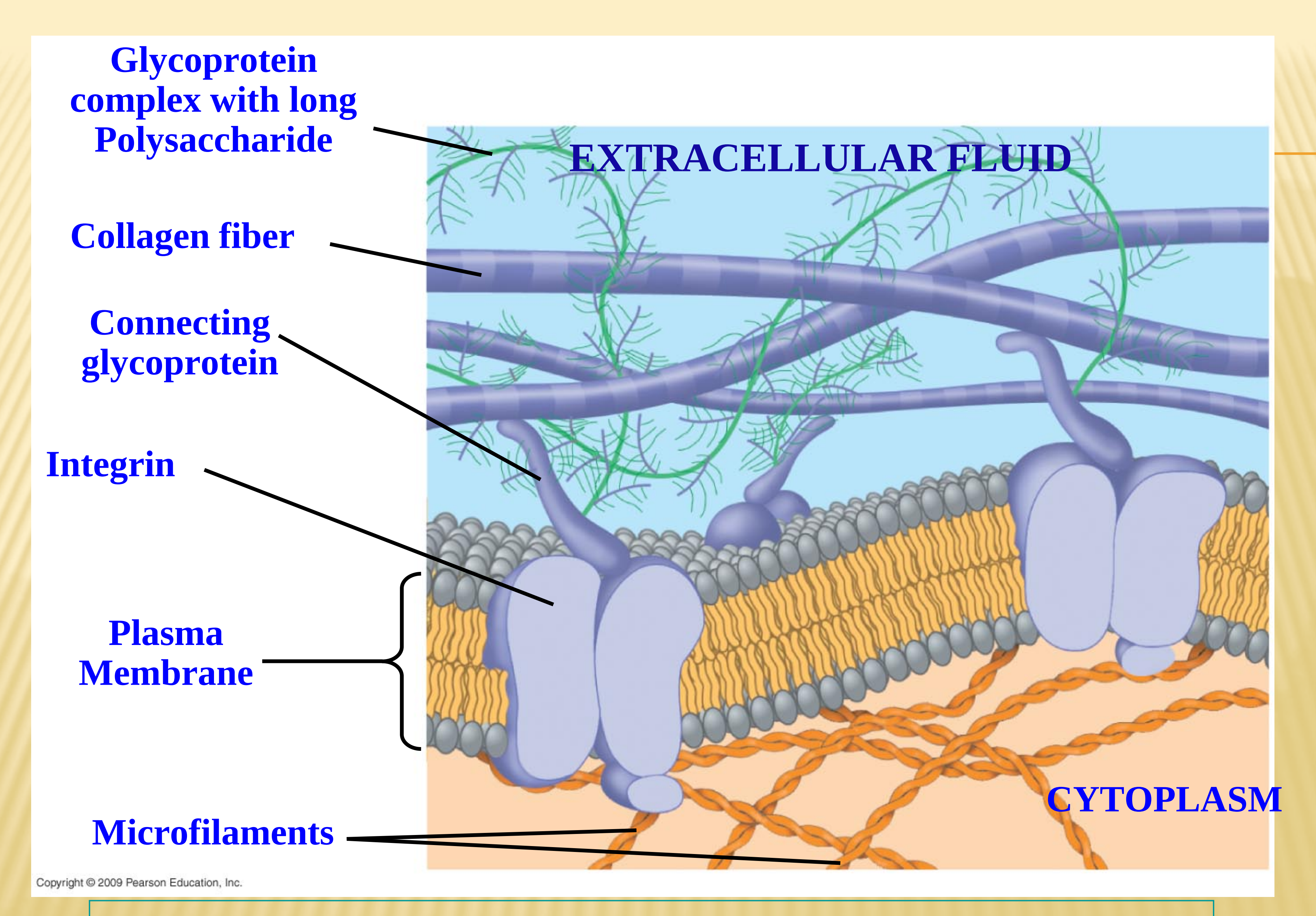
- ❖ **Although differences exist, flagella and cilia have a common structure and mechanism of movement, except that Cilia are short and flagella are longer and fewer**

The extracellular matrix of animal cells functions in support, movement, and regulation

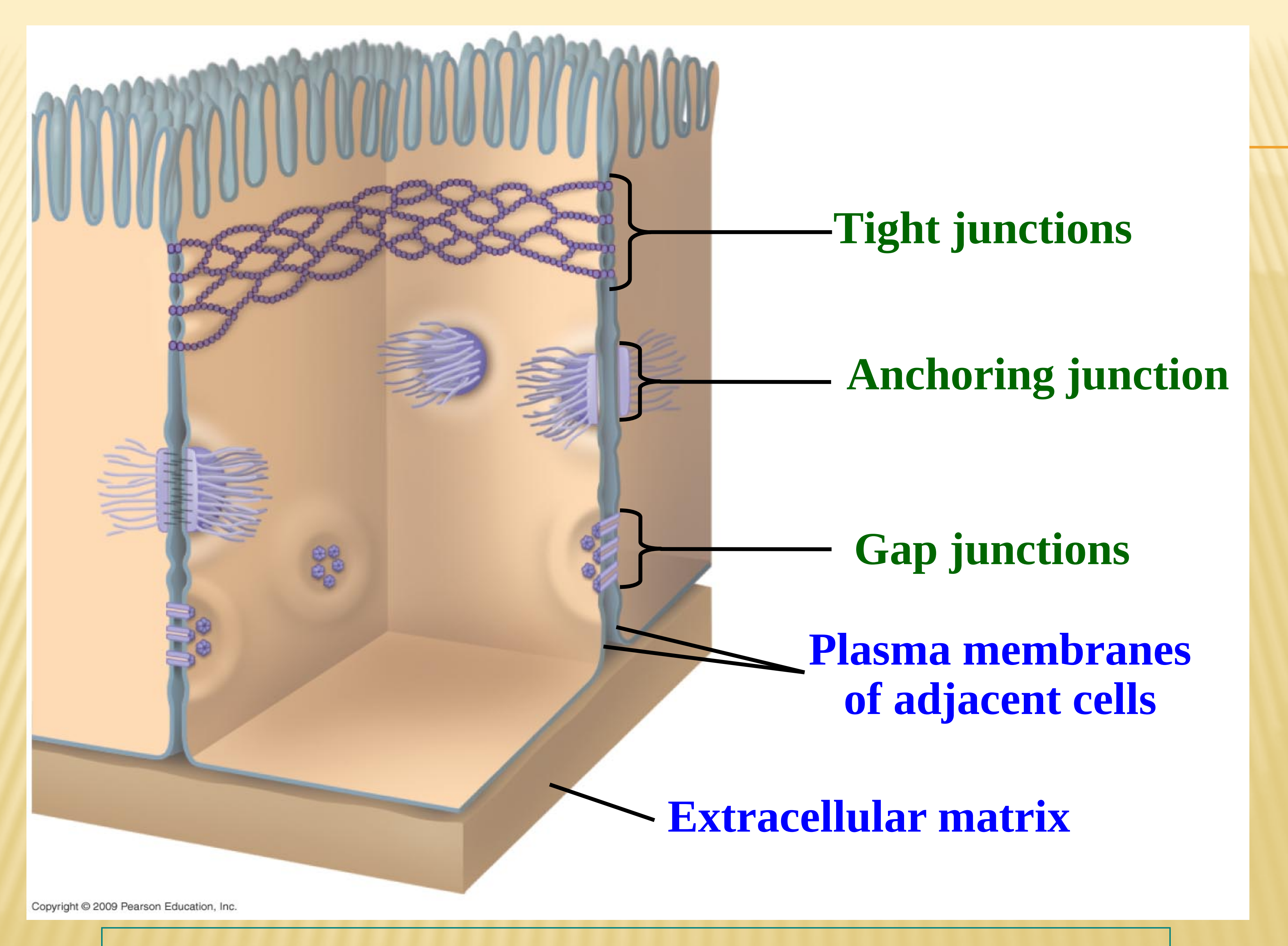
- **Cells synthesize and secrete the extracellular matrix (ECM) that is essential to cell function**
  - **The ECM is composed of strong fibers of collagen, which holds cells together and protects the plasma membrane**
  - **ECM attaches through connecting proteins that bind to membrane proteins called integrins**
  - **Integrins span the plasma membrane and connect to microfilaments of the cytoskeleton**

Cell junctions of animal tissues

- **Adjacent cells communicate, interact, and adhere through specialized junctions between them**
  - **Tight junctions prevent leakage of extracellular fluid across a layer of epithelial cells**
  - **Anchoring junctions fasten cells together into sheets**
  - **Gap junctions are channels that allow molecules to flow between cells**

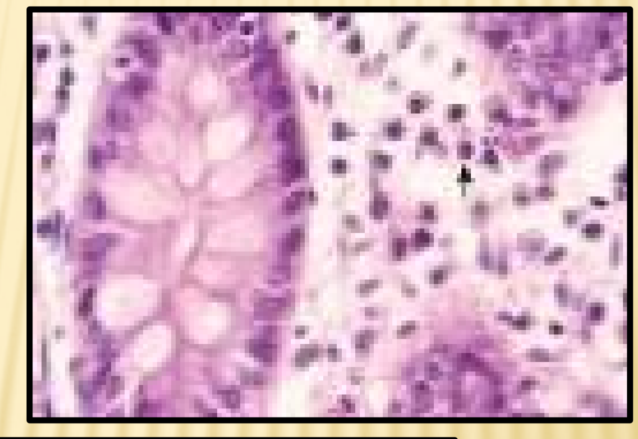


The extracellular matrix (ECM) of an animal cell



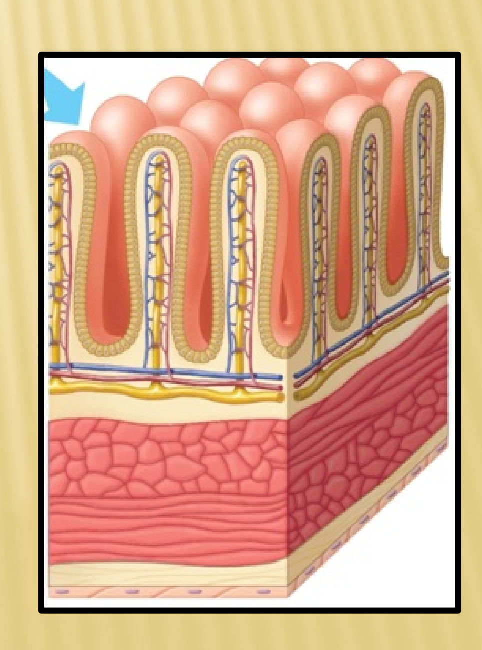
Three types of cell junctions in animal tissues

Chapter 5
Tissues









ANIMAL TISSUES

Tissue

- **A group of similarly specialized cells**

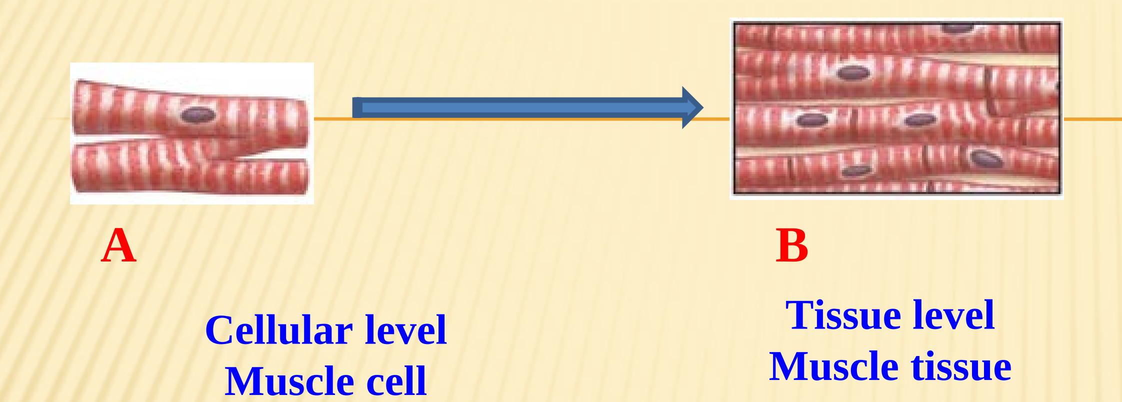
- **Associated to perform one or more functions**



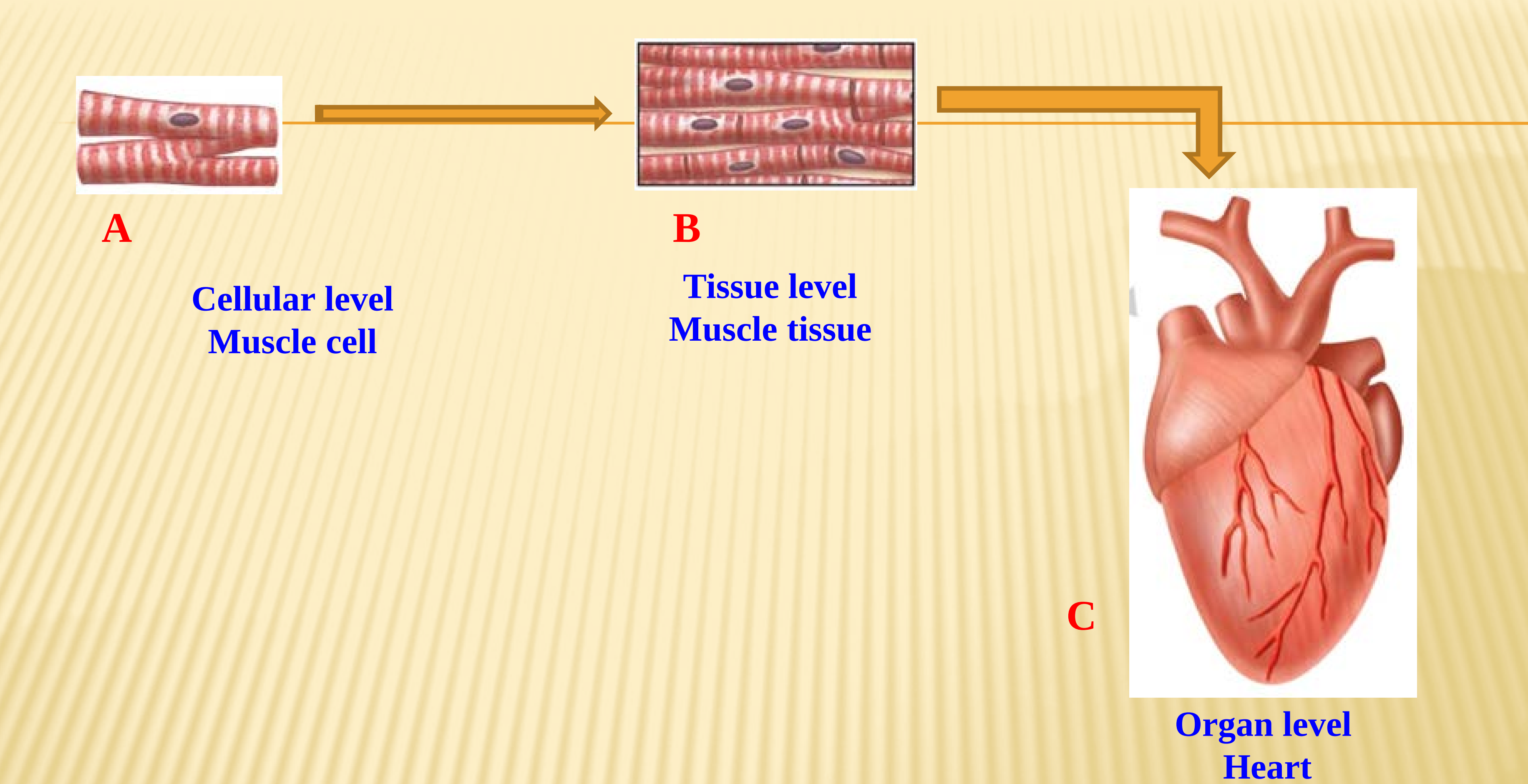
A

Cellular level
Muscle cell

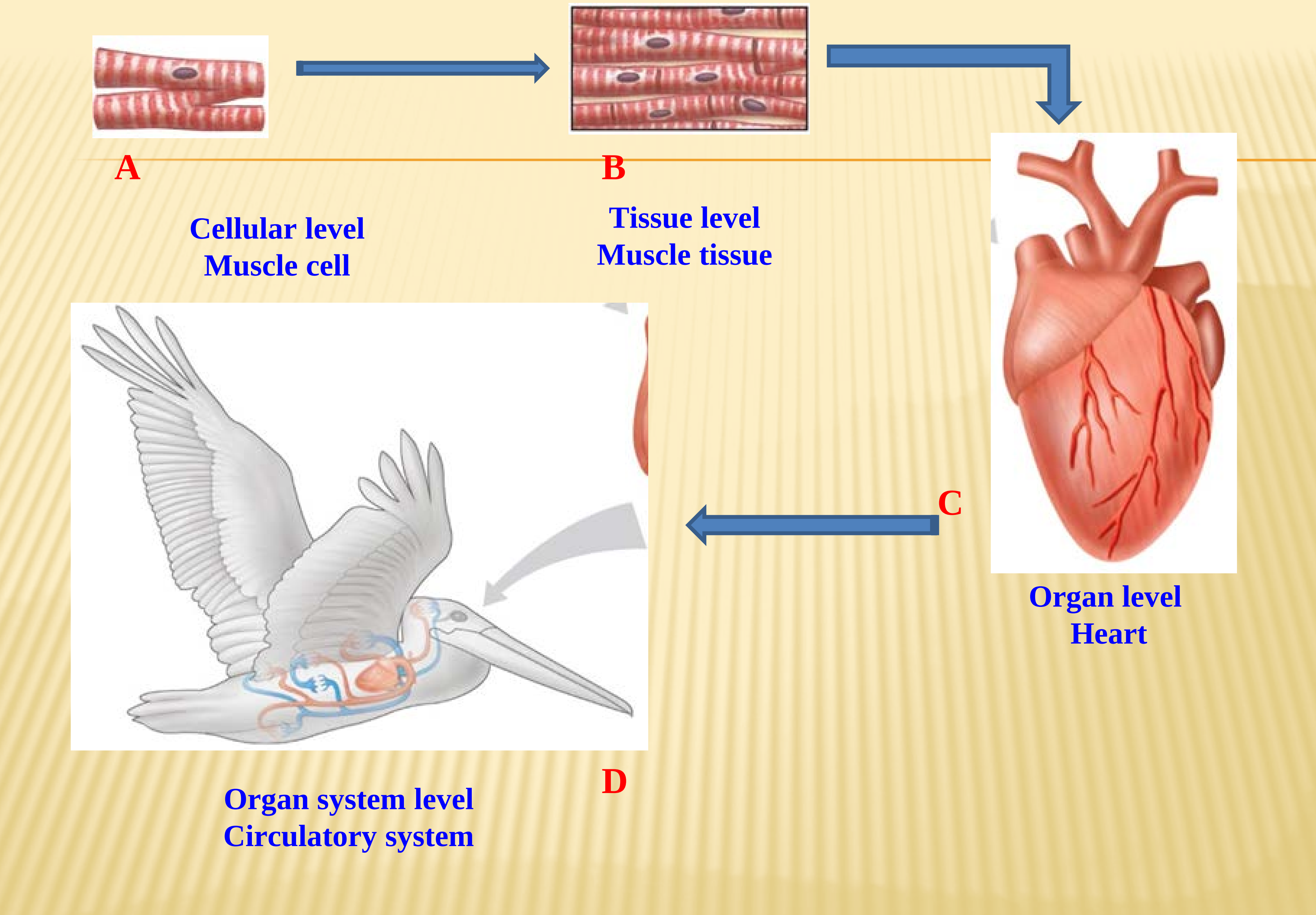
An example of structural hierarchy in a pelican



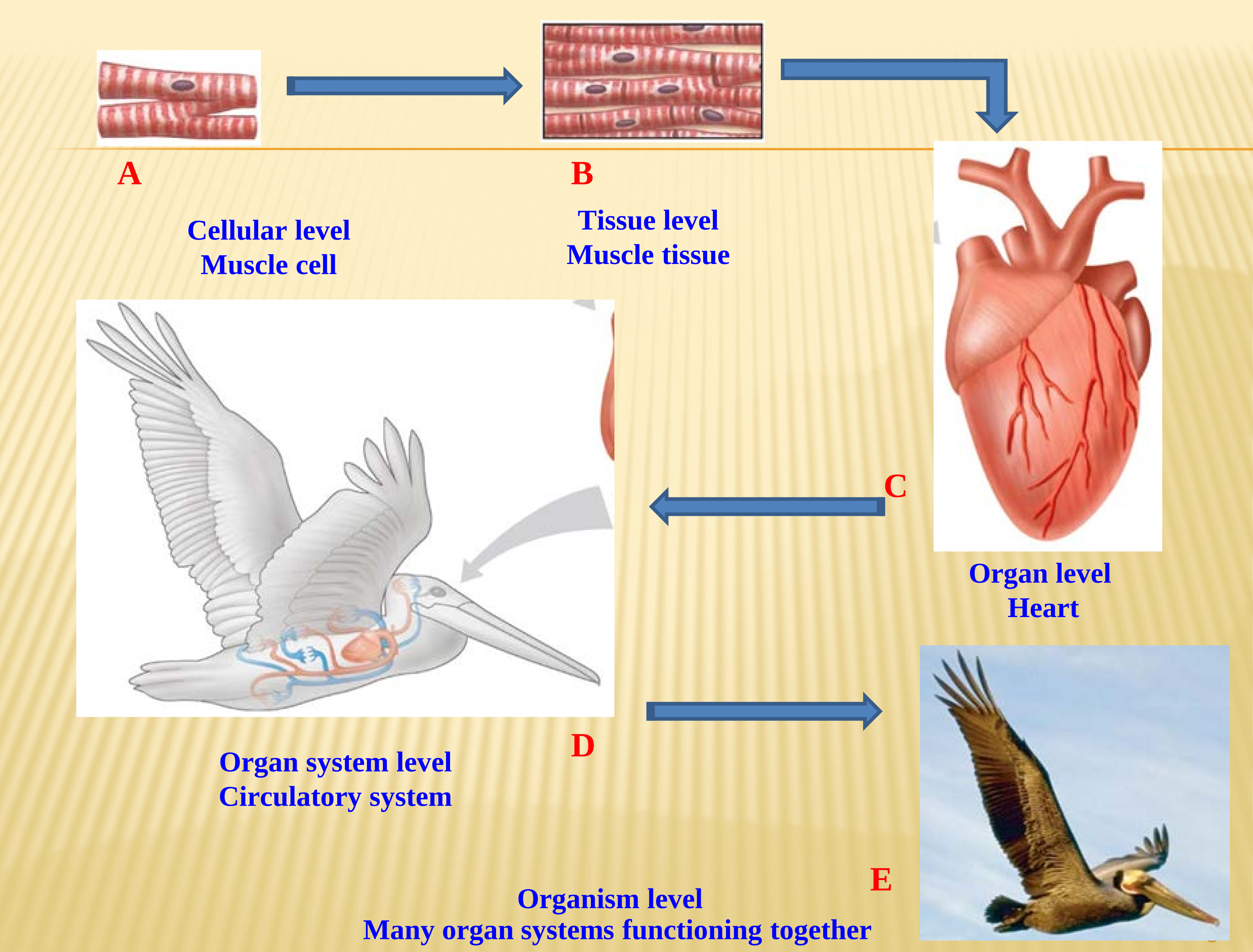
An example of structural hierarchy in a pelican



An example of structural hierarchy in a pelican



An example of structural hierarchy in a pelican


A
Cellular level
Muscle cell
B
Tissue level
Muscle tissue
C
Organ level
Heart
D
Organ system level
Circulatory system
E
Organism level
Many organ systems functioning together

Structure fits function

Animals consist of a hierarchy of levels of organization

Structure fits function at all levels of organization in the animal body

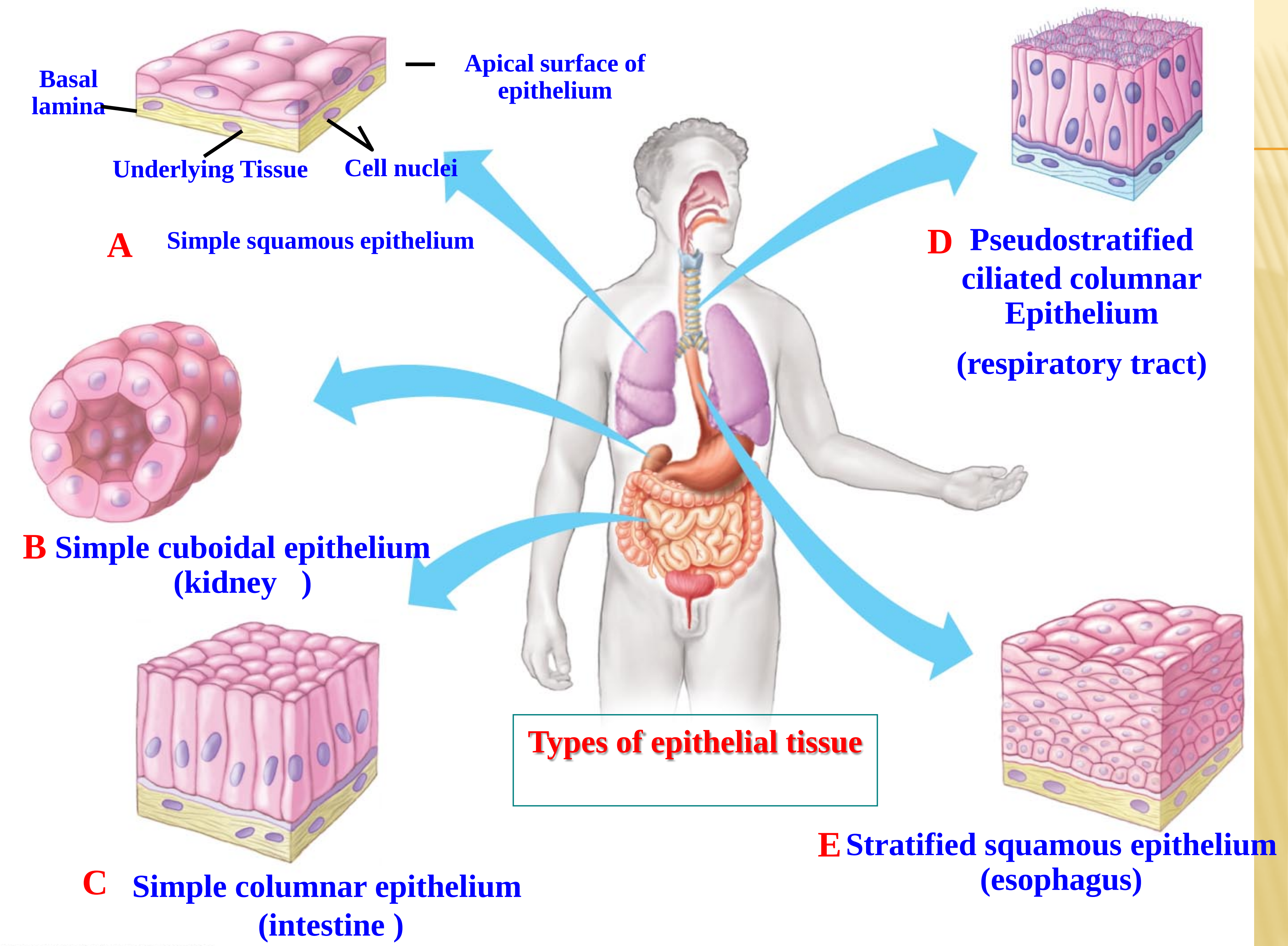
Tissues are groups of cells with a common structure and function

- **Animals have four main categories of tissues**
  1) **Epithelial tissue**
  2) **Connective tissue**
  3) **Muscle tissue**
  4) **Nervous tissue**

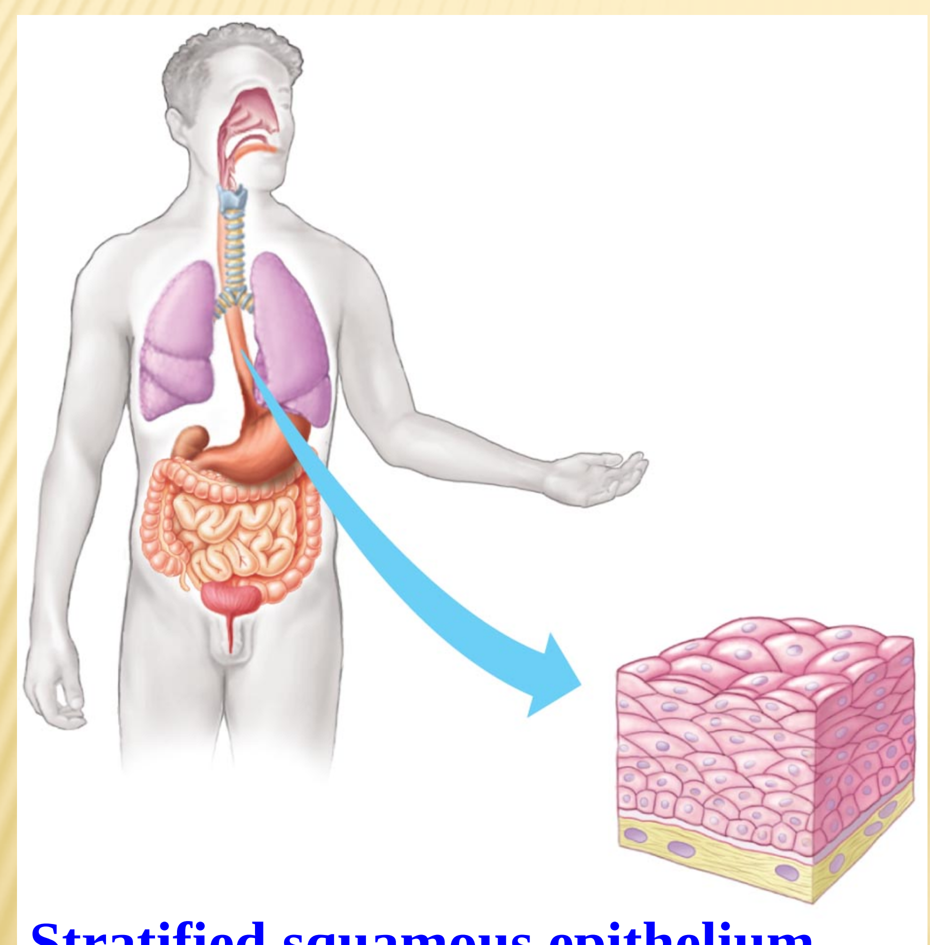
1. Epithelial Tissue (Epithelium)

- A continuous layer (sheet) of cells
  - covering a body surface
  - lining a body organs and cavity

- Functions in protection, absorption, secretion, or sensation


Basal lamina
Apical surface of epithelium
Underlying Tissue
Cell nuclei
A Simple squamous epithelium
D Pseudostratified ciliated columnar Epithelium
(respiratory tract)
B Simple cuboidal epithelium
(kidney)
Types of epithelial tissue
C Simple columnar epithelium
(intestine)
E Stratified squamous epithelium
(esophagus)
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Epithelial tissue covers the body and lines its organs and cavities



Stratified squamous epithelium (esophagus)

- **Stratified epithelial cells are stacked on top of each other**

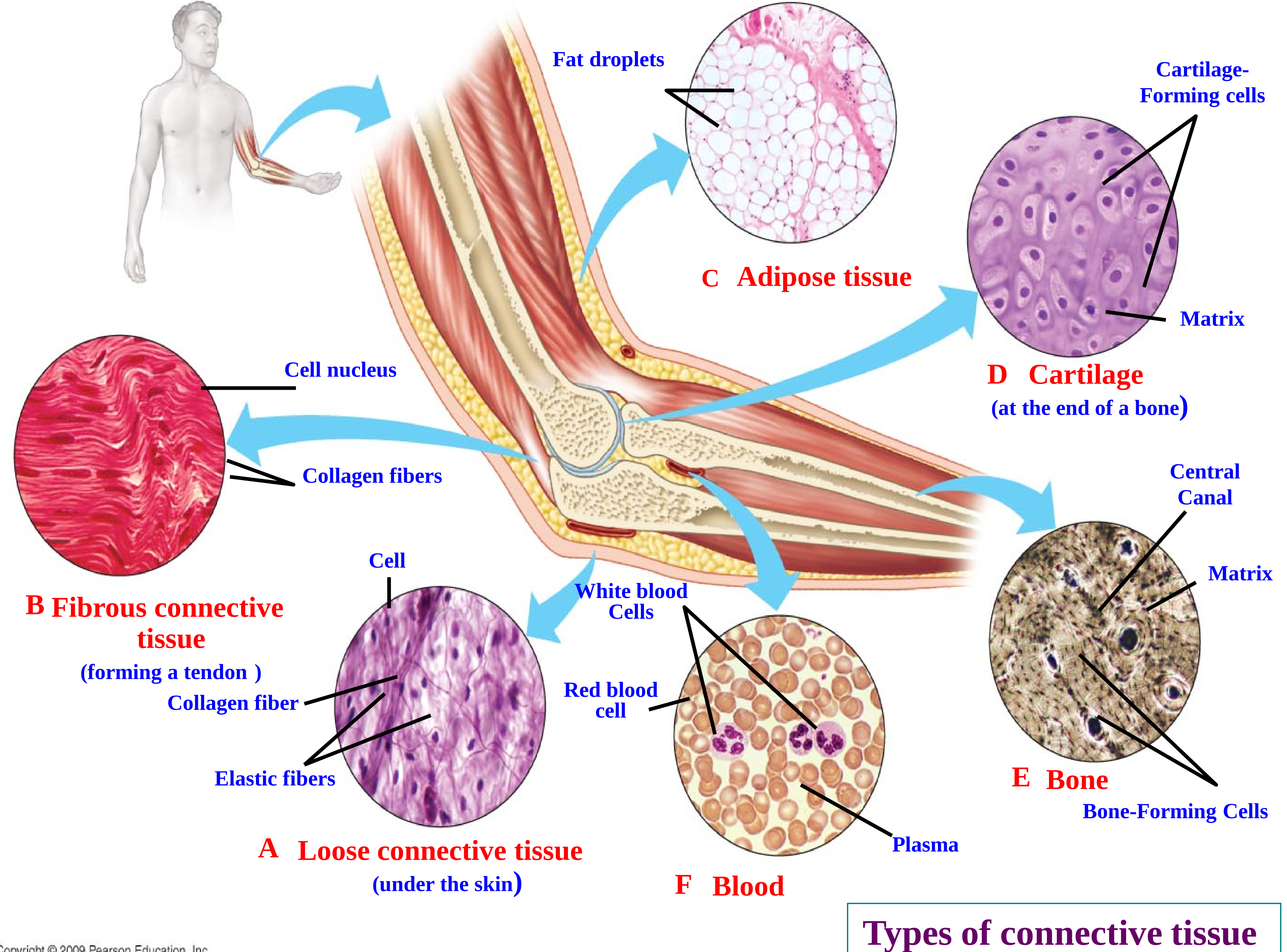
Types of epithelial tissue; Stratified squamus epithelium (lining the esophagus)

Connective Tissues

- Cells embedded in intercellular substance
  - Microscopic collagen fibers, elastic fibers, reticular fibers (thin branched fibers)
  - Scattered through a matrix (thin gel of polysaccharides)

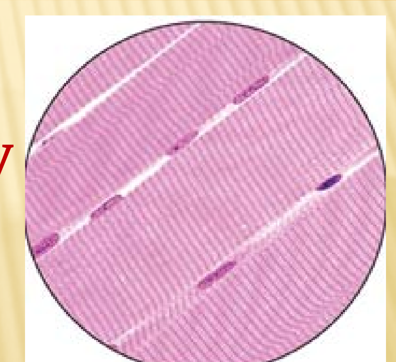
Connective tissue

- **Connective tissue can be grouped into six major types**
  1. **Loose connective tissue (under the skin)**
  2. **Fibrous connective tissue (forming a tendon)**
  3. **Adipose tissue**
  4. **Cartilage (at the end of a bone**
  5. **Bone - Bone-Forming Cells**
  6. **Blood**

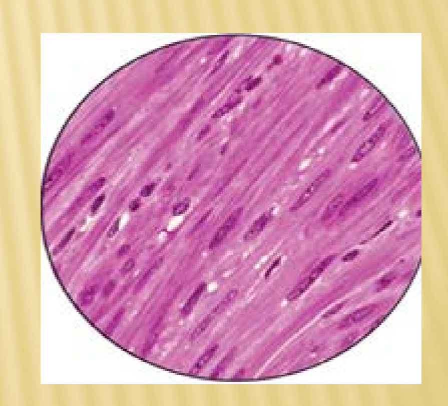

Fat droplets
C Adipose tissue
Cartilage-
Forming cells
Matrix
D Cartilage
(at the end of a bone)
Cell nucleus
Collagen fibers
B Fibrous connective
tissue
(forming a tendon)
Cell
Collagen fiber
Elastic fibers
A Loose connective tissue
(under the skin)
White blood
Cells
Red blood
cell
Plasma
F Blood
Central
Canal
Matrix
E Bone
Bone-Forming Cells
Types of connective tissue

Muscle tissues; function in movement

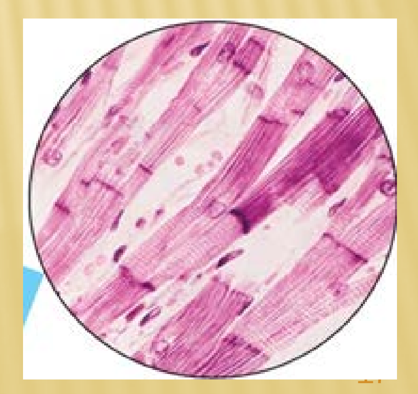
A. **Skeletal muscle causes voluntary movements. Striated and under voluntary control, move parts of the body**

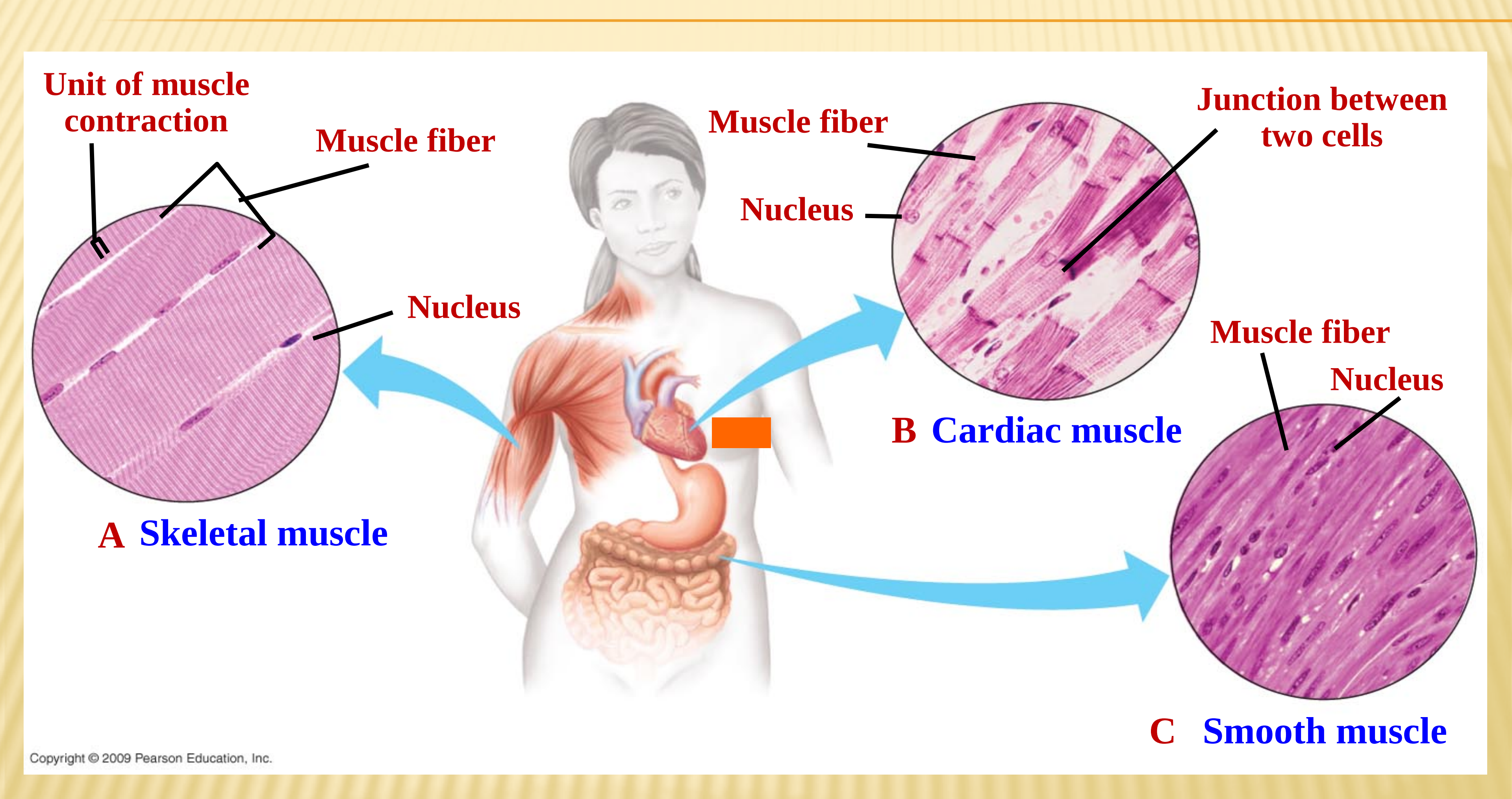


B. **Smooth muscle moves walls of internal organs, such as the intestines. No striations, contractions involuntary**



C. **Cardiac muscle pumps blood. Striated, contractions are involuntary. Muscle contracts, heart pumps blood**





The three types of muscle

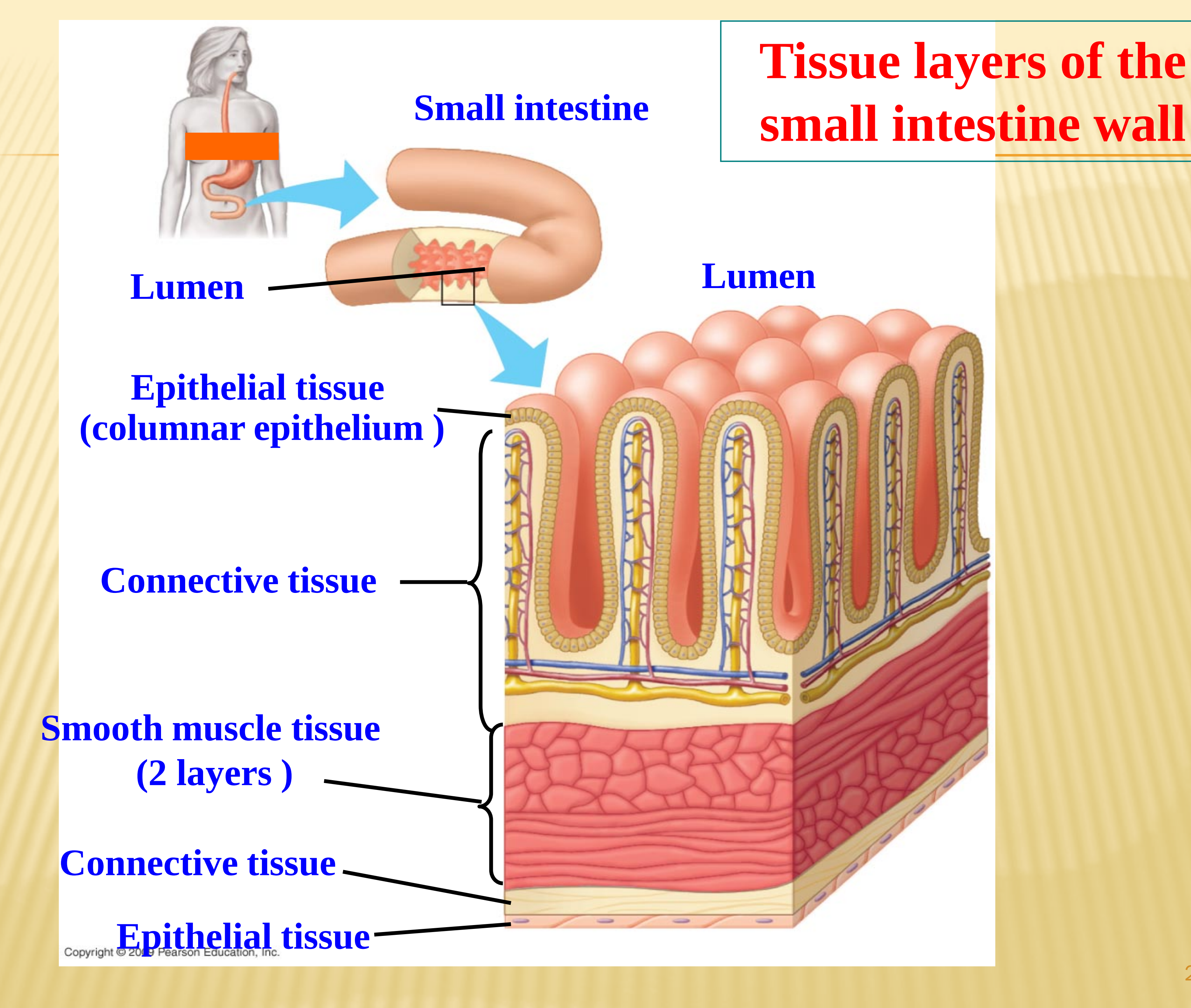
Nervous tissue (Neuron cells)

- **Neurons**
  - **Carry signals by conducting electrical impulses**
  - **Elongated cells**
  - **Receives and transmits information**
- **Synapse**
  - **A junction between neurons**

Organs are made up of tissues

- **Each tissue performs specific functions**
- **The heart has epithelial, connective, and nervous tissues**
  - **Epithelia line the heart chambers**
  - **Connective tissues make the heart elastic**
  - **Neurons regulate contractions**

Tissue layers of the small intestine wall



PLANT TISSUES

Three tissue systems make up the plant body

1. Dermal tissue

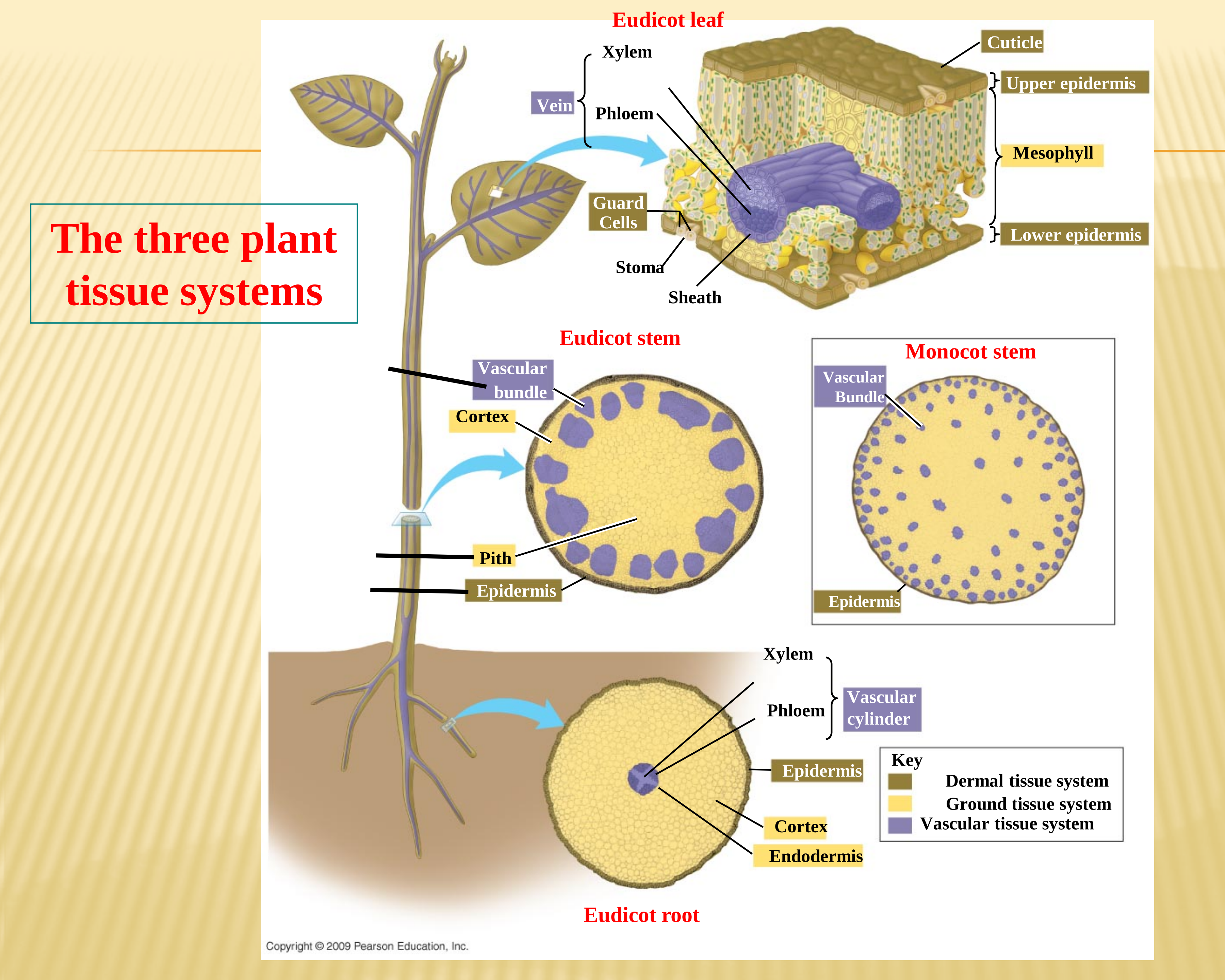
- **Layer of tightly packed cells called the epidermis**
- **First line of defense against damage and infection**
- **Waxy layer called cuticle, lies on the top of epidermis, and reduces water loss.**

2. Vascular tissue

- Support and long-distance transport
- Composed of xylem and phloem
- Arranged in bundles

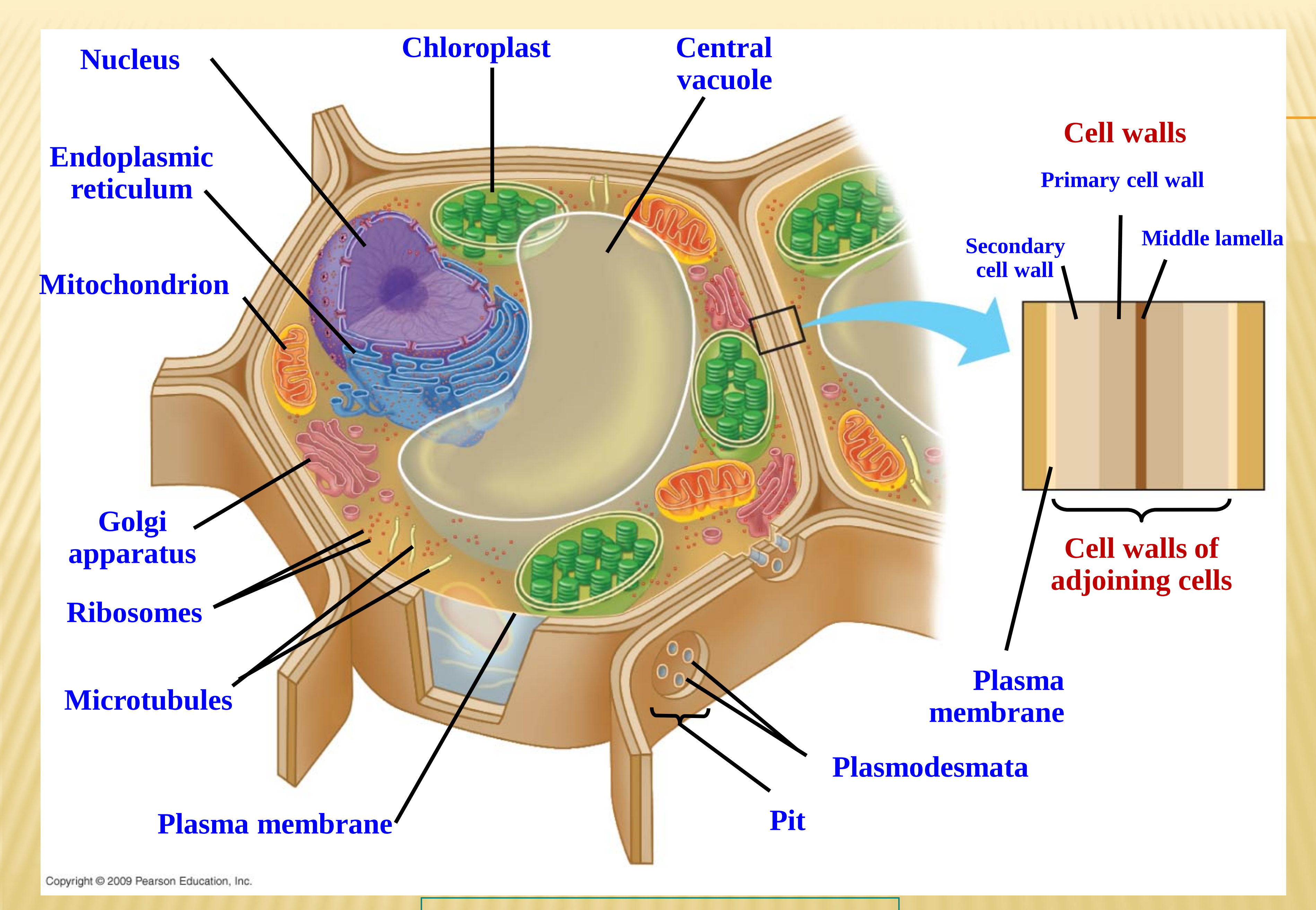
3. Ground tissue

- The bulk of the plant body
- Food production, storage & support
- Lies between dermal and vascular tissue
- In Eudicot stem ground tissue is divided into pith and cortex
- Leaf ground tissue is called mesophyll


The three plant tissue systems
Eudicot leaf
Xylem
Vein
Phloem
Cuticle
Upper epidermis
Mesophyll
Guard Cells
Stoma
Sheath
Lower epidermis
Eudicot stem
Vascular bundle
Cortex
Pith
Epidermis
Monocot stem
Vascular Bundle
Epidermis
Xylem
Phloem
Vascular cylinder
Epidermis
Cortex
Endodermis
Key
Dermal tissue system
Ground tissue system
Vascular tissue system
Eudicot root
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Plant cells and tissues are diverse in structure and function

- **Plant cell wall**
  - **Some plant cell walls have two layers**
    - **Primary cell wall — outermost layer**
    - **Secondary cell wall — tough layer inside primary wall**
  - **A sticky layer called the middle lamella lies between adjacent plant cells**
  - **Openings in cell walls called plasmodesmata allow cells to communicate and exchange materials easily**



The structure of a plant cell

Plant Tissue Systems

1. **Ground Tissue System consists of 3 tissues,**
   - ❖ **Parenchyma tissue**
   - ❖ **Collenchyma tissue**
   - ❖ **Sclerenchyma tissue**

2. **Vascular Tissue System consists of 2 tissues**
   - ❖ **Xylem tissue**
   - ❖ **Phloem tissue**

Plant cells and tissues

- **Plant cell structure is related to function**
- **There are five major types of plant cells**

1- Parenchyma cells making parenchyma tissue. Function in photosynthesis, food and water storage

2- Collenchyma cells making collenchyma tissue. Provide flexible support

3- Sclerenchyma cells making sclerenchyma tissue. Provide rigid support.

4- Water-conducting cells making xylem tissue.

5- Food-conducting cells making phloem tissue.

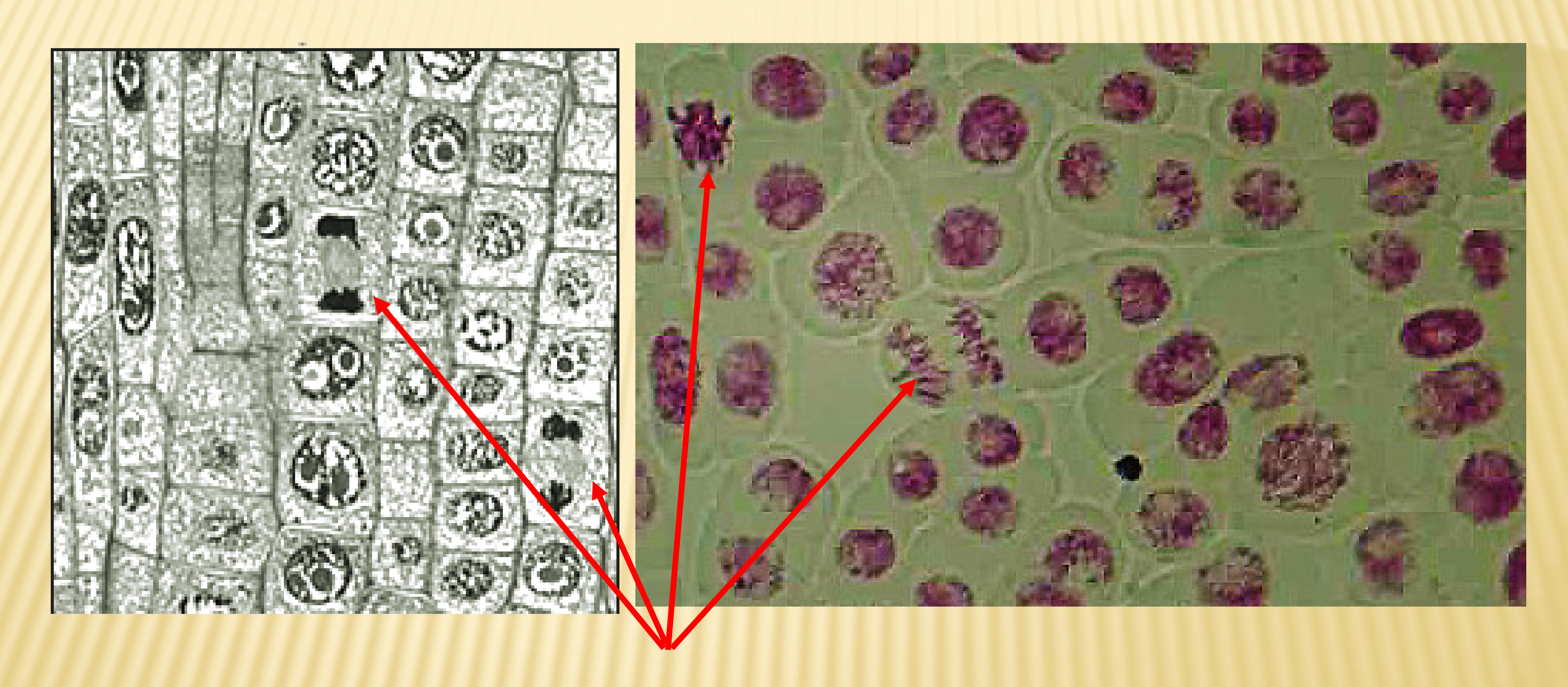
Plant Meristematic tissues

- They are located at the tips of roots and stems, between the water- and food-conducting tissues of stems, and at various other places in plant bodies.

- capable of producing new cells by cell-division.

- Source of differentiation: they give rise to all other kinds of tissues

Plant Meristematic tissues



Microscopic photographs of the meristematic cells in the tip of onion roots showing cell division (Arrows)

Chapter 6

BIOENERGETICS

Transport across membranes

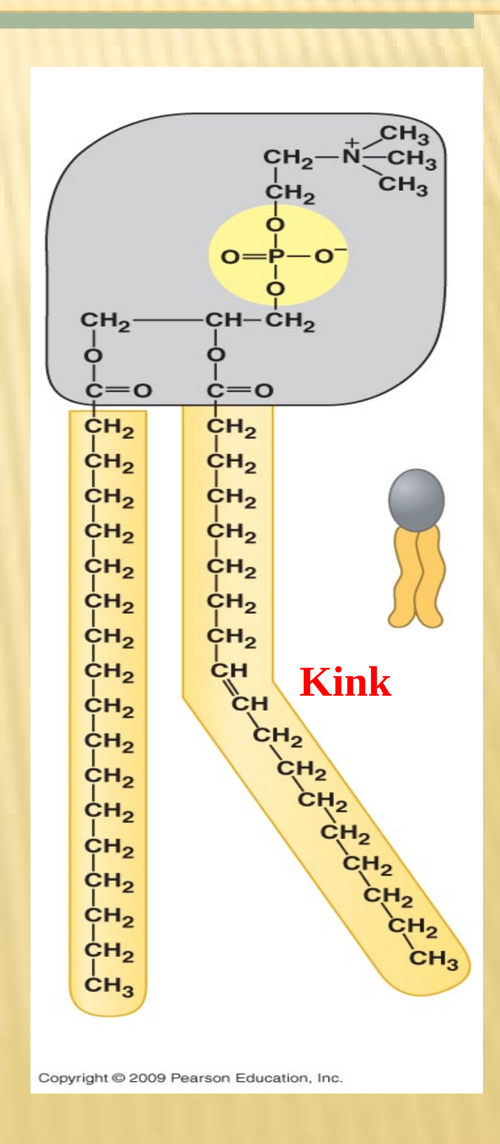
MEMBRANE STRUCTURE AND FUNCTION

Membranes are a fluid mosaic of phospholipids and proteins

- **Membranes are composed of phospholipids bilayer and proteins**

- **Many phospholipids are made from unsaturated fatty acids that have kinks in their tails that keep the membrane fluid phospholipid Contains 2 fatty acid chains that are nonpolar**

- **Are nonpolar and Head is polar & contains a –PO4 group & glycerol**



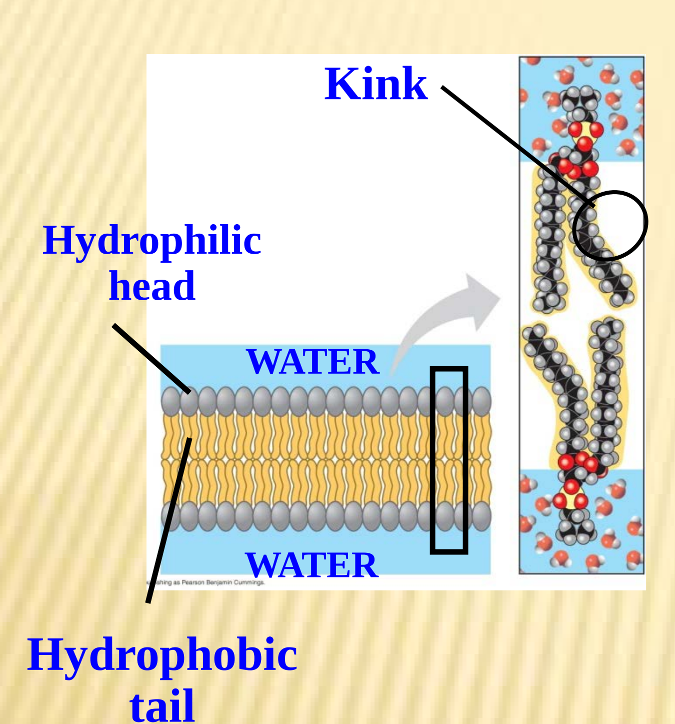
Membranes are a fluid mosaic of phospholipids and proteins

Membranes are commonly described as a fluid mosaic

FLUID- because individual phospholipids and proteins can move side-to-side within the layer, like it's a liquid.

The fluidity of the membrane is aided by cholesterol wedged into the bilayer to help keep it liquid at lower temperatures.

MOSAIC- because of the pattern produced by the scattered protein molecules embedded in the phospholipids when the membrane is viewed from above.



Phospholipid Bilayer

Hydrophobic regions of protein

Hydrophilic regions of protein

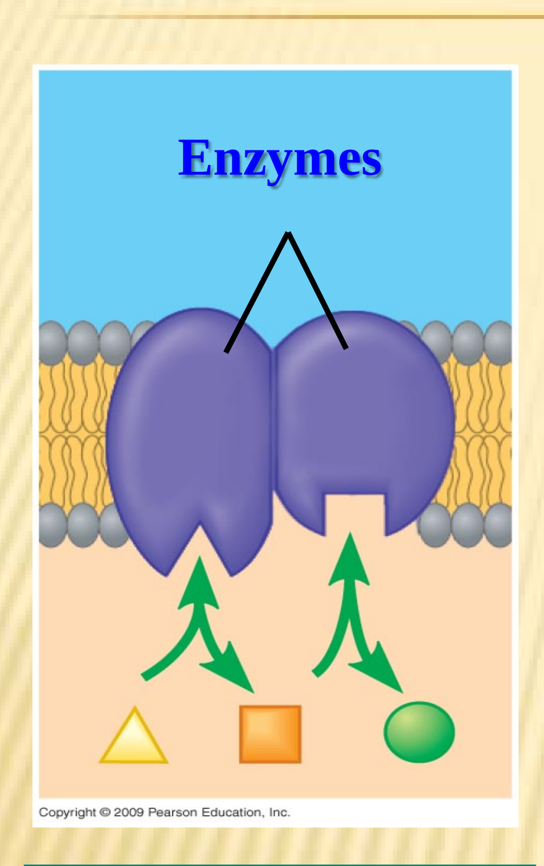
Phospholipid bilayer (cross section)

The fluid mosaic model for membranes

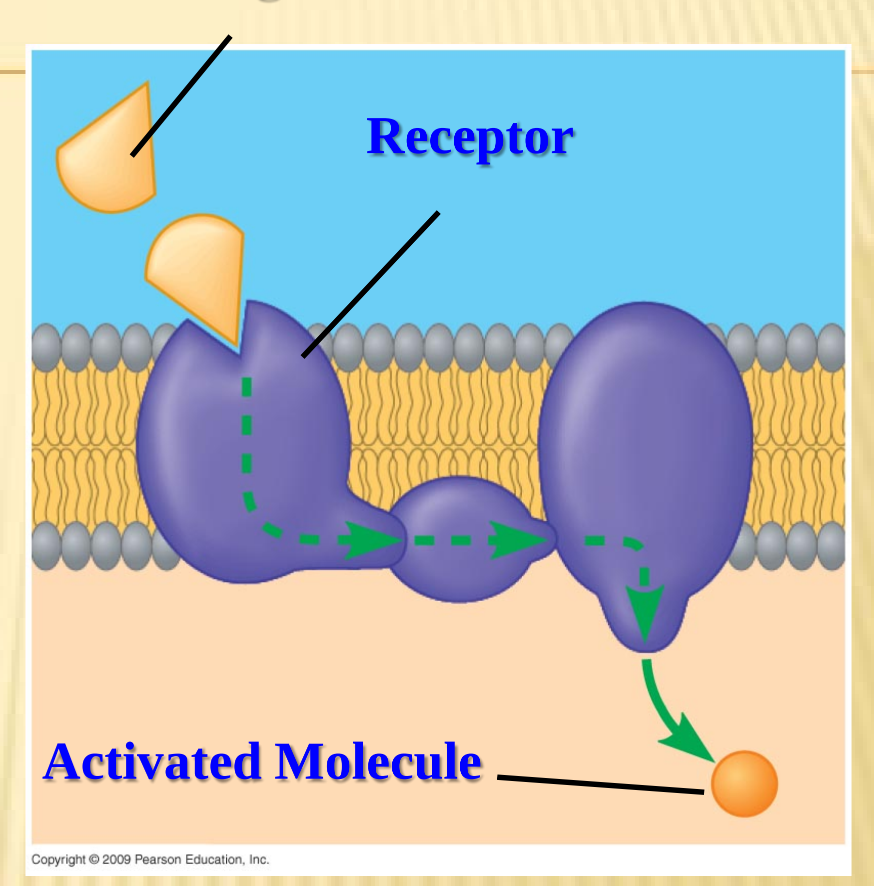
Functions of Plasma Membrane

Many membrane proteins function as

- **Enzymatic activity**
- **Transport**
- **Bind cells together (junctions)**
- **Protective barrier**
- **Regulate transport in & out of cell (selectively permeable)**
- **Allow cell recognition**
- **Signal transduction**



Enzyme activity



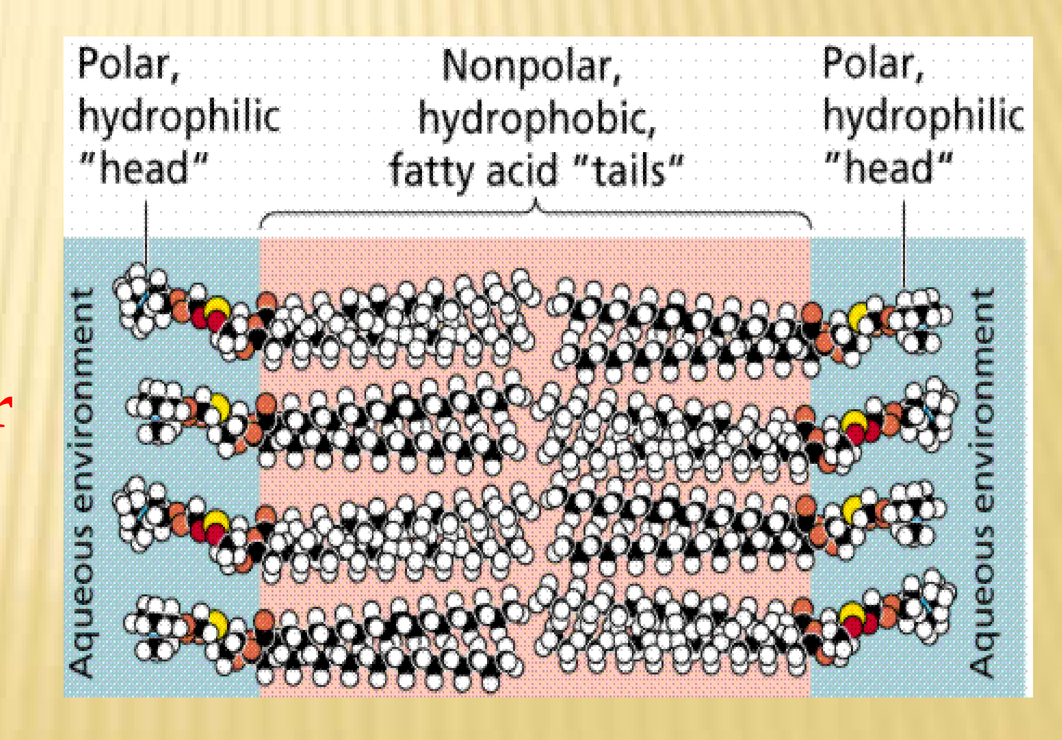
Signal transduction

Membranes are a fluid mosaic of phospholipids and proteins

- Because membranes allow some substances to cross or be transported more easily than others, they exhibit **selective permeability.**

Nonpolar hydrophobic molecules, Materials that are soluble in lipids can pass through the cell membrane easily.

- **Small molecules** e.g. O_2, CO_2, H_2O move through easily.
- **Ions , Polar hydrophilic** molecules **larger than water** (glucose, other sugars and amino acids) do not cross easily **on their own**.



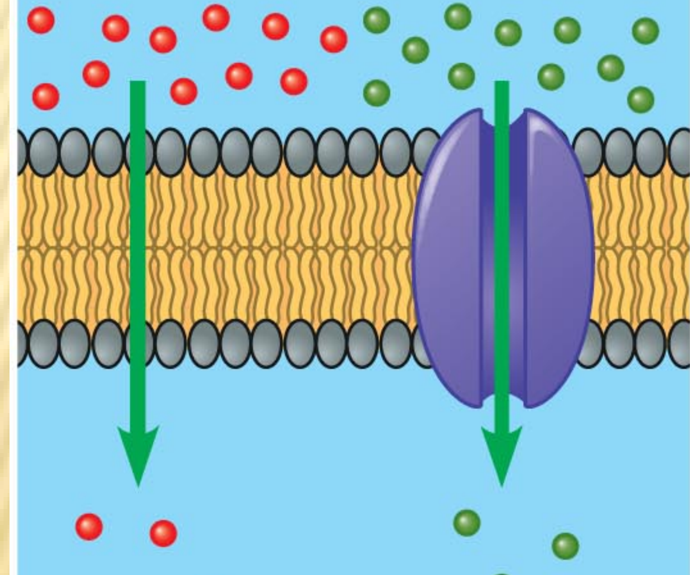
Types of Transport Across Cell Membranes

Requires no energy

Passive transport

Diffusion | **Facilitated diffusion**

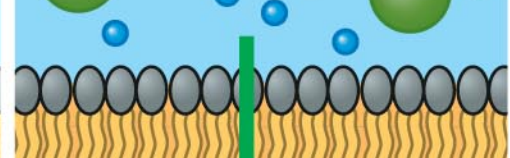
Higher solute concentration

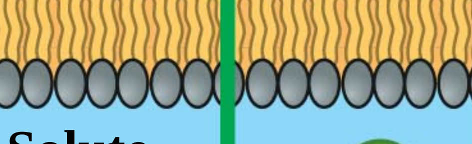


Lower solute concentration

Osmosis

Higher water concentration







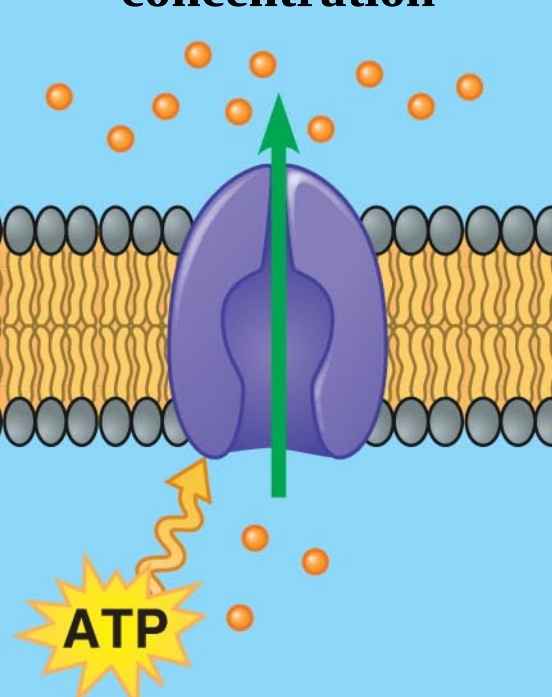
Water

Lower water concentration

Requires energy

Active transport

Higher solute concentration

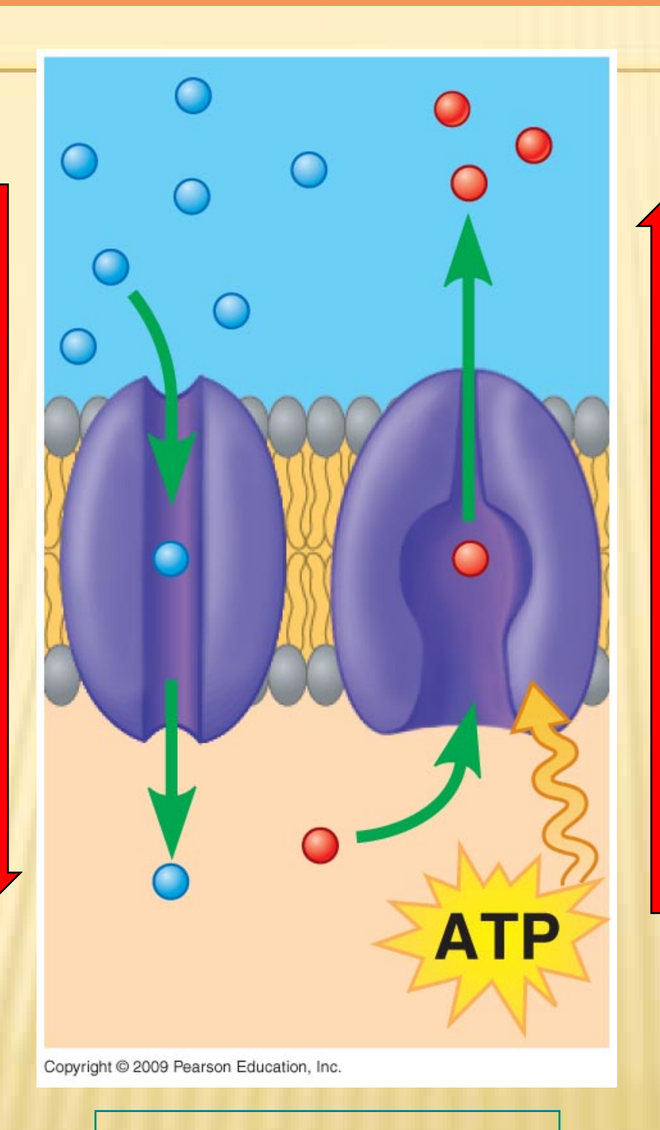


Lower solute concentration

Concentration Gradient

Passive Transport

From a region of higher to lower concentration



High Concentration

Active Transport (against concentration gradient)

Low Concentration

Transport

Passive transport is diffusion across a membrane with no energy investment

- **Diffusion** **Net movement of substance down its concentration gradient**
  - **from region of greater concentration**
  - **to region of lower concentration**
- **Does not use direct metabolic energy**
- **Is a process in which particles spread out evenly in an available space**

Passive transport is diffusion across a membrane with no energy investment

- This means that particles diffuse down their **concentration gradient**, molecules move because they have a natural **KINETIC ENERGY**

- Eventually, the particles reach **equilibrium** where the concentration of particles is the same throughout

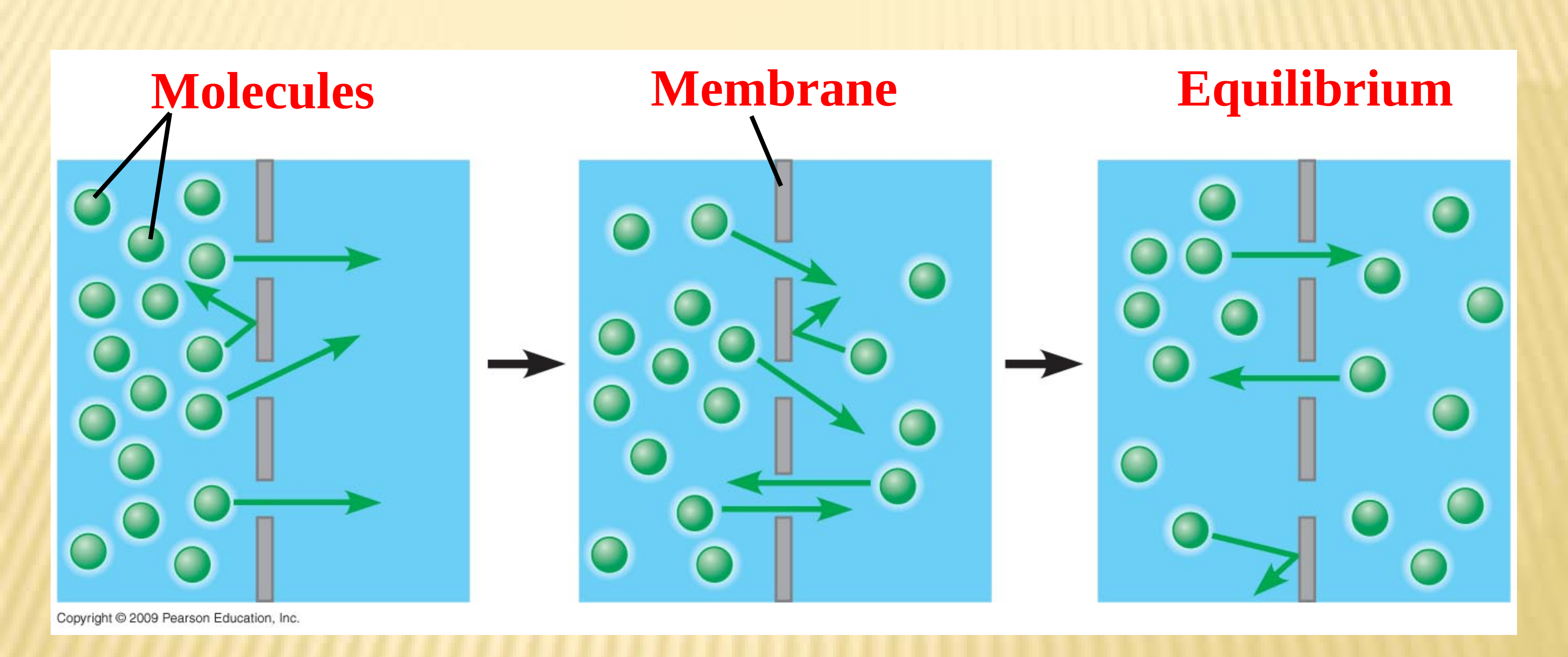
Passive transport is diffusion across a membrane with no energy investment

- Passive transport
- Diffusion across a cell membrane does not require energy, so it is called passive transport
  - The concentration gradient itself represents potential energy for diffusion
  - Passive transport could be:

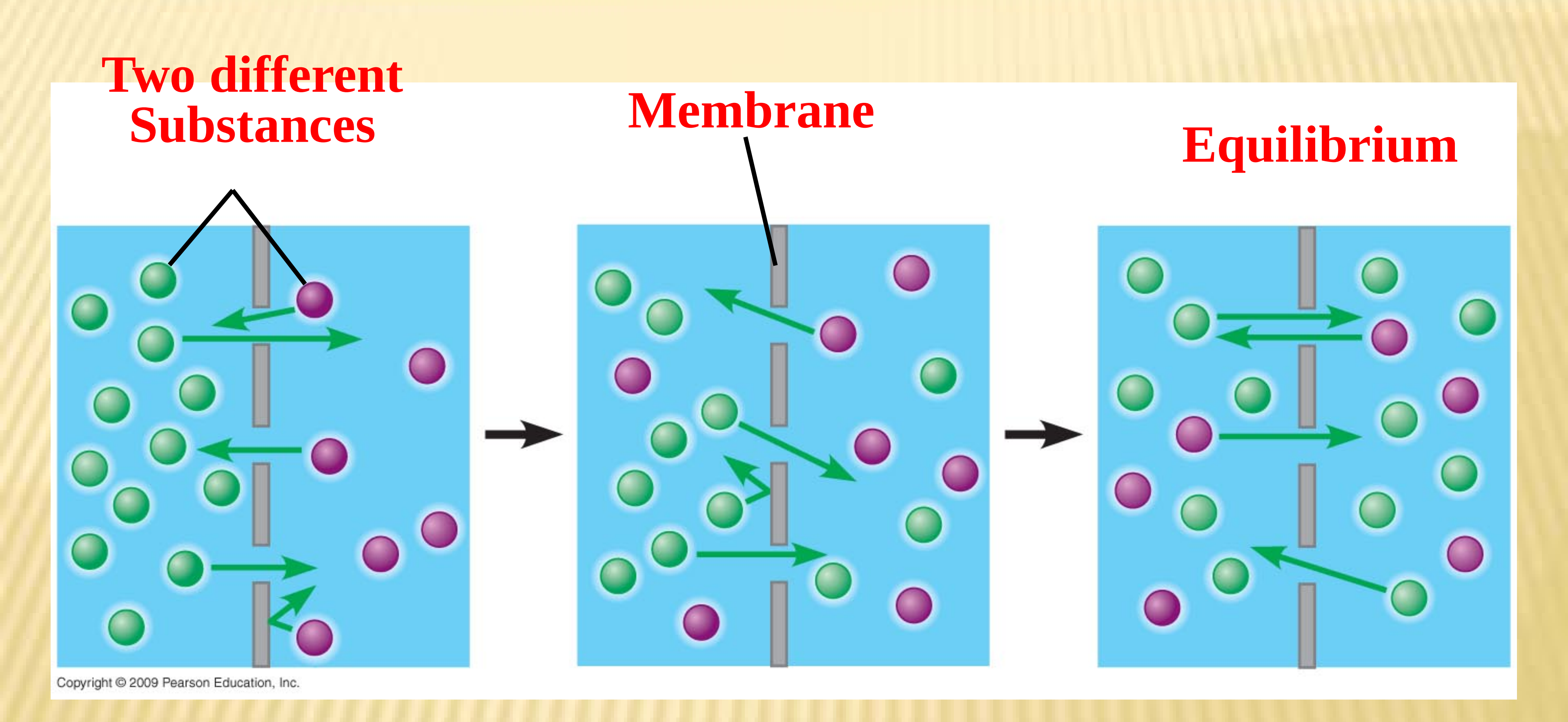
1) Simple diffusion: Example: Oxygen or water diffusing into a cell and carbon dioxide diffusing out.
2) Facilitated diffusion: Uses transport proteins to move high to low concentration

   Examples: Glucose or amino acids moving from blood into a cell

Passive transport (simple diffusion)

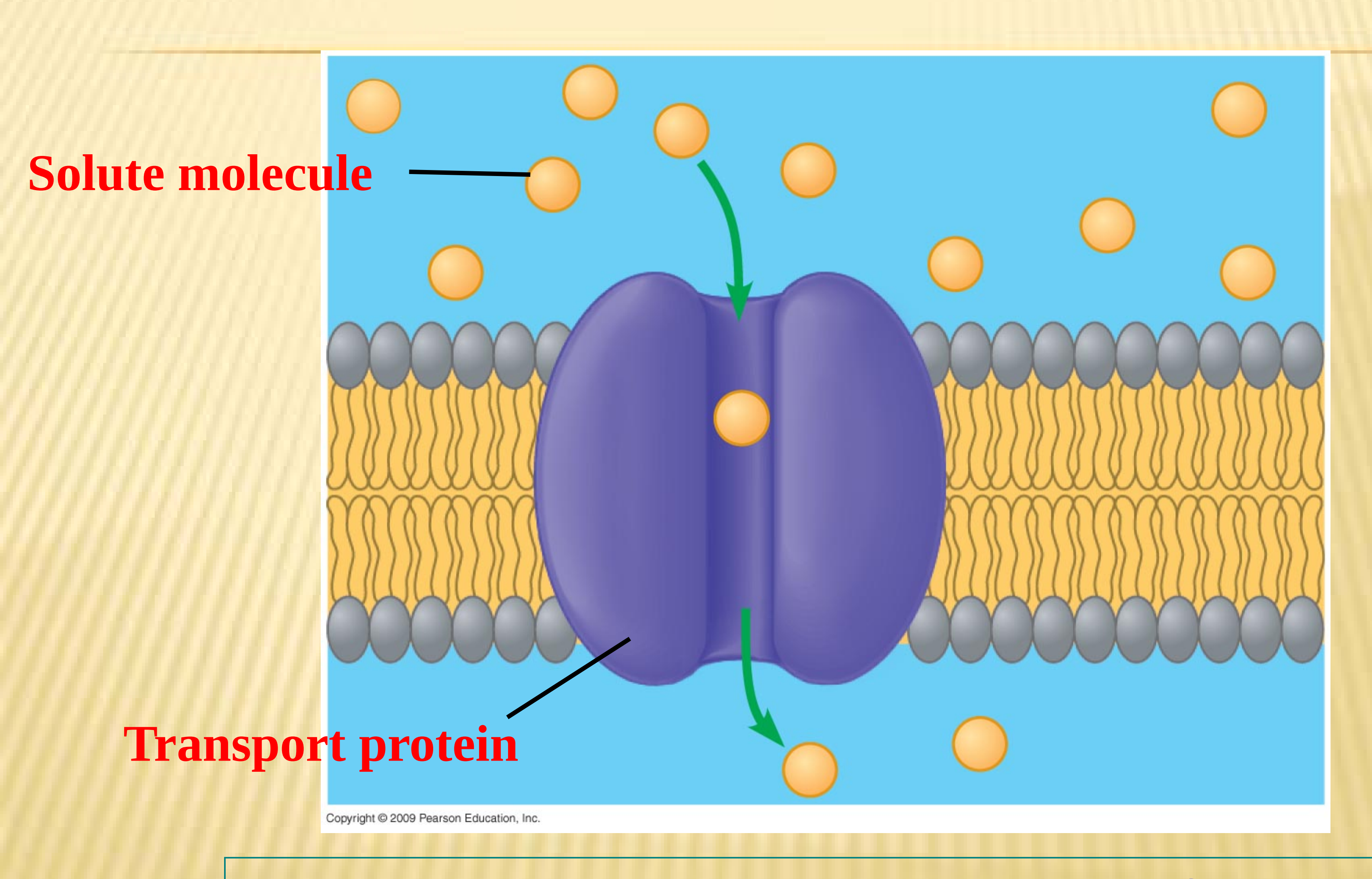


Passive transport of one type of molecule

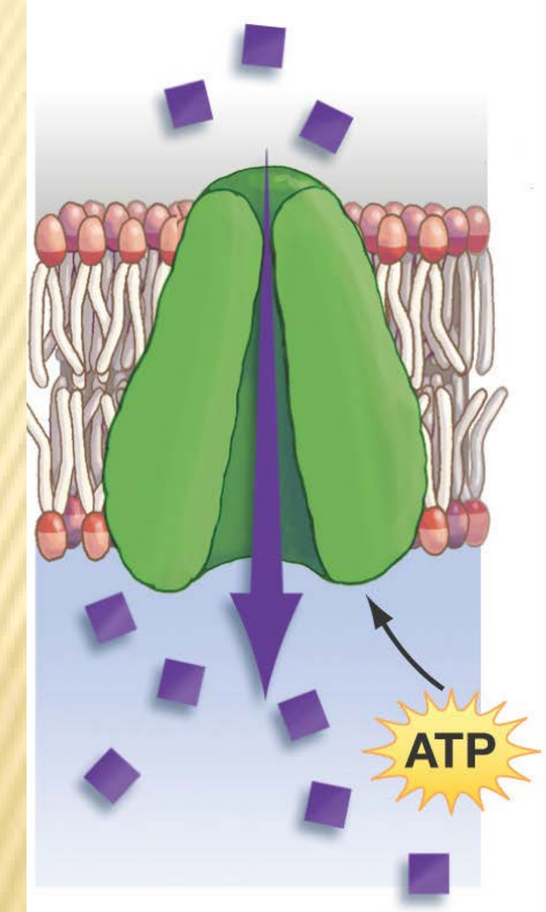


Passive transport of two types of molecules

Passive transport Facilitated diffusion

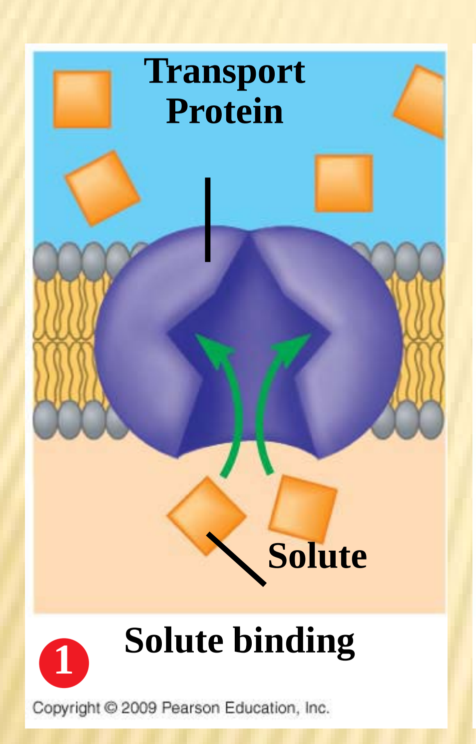


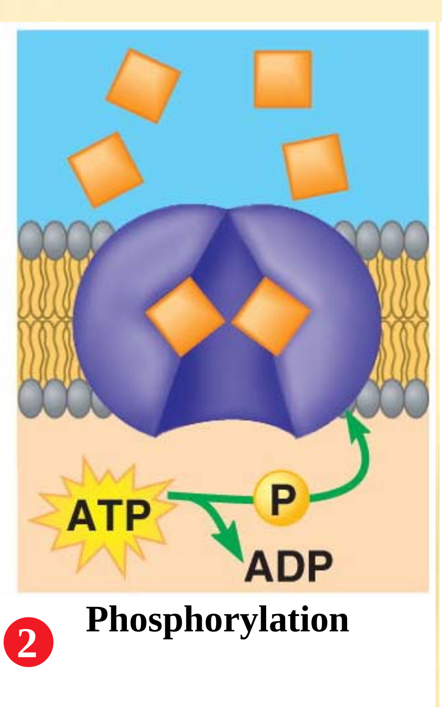
Transport protein providing a channel for the diffusion of a specific solute across a membrane

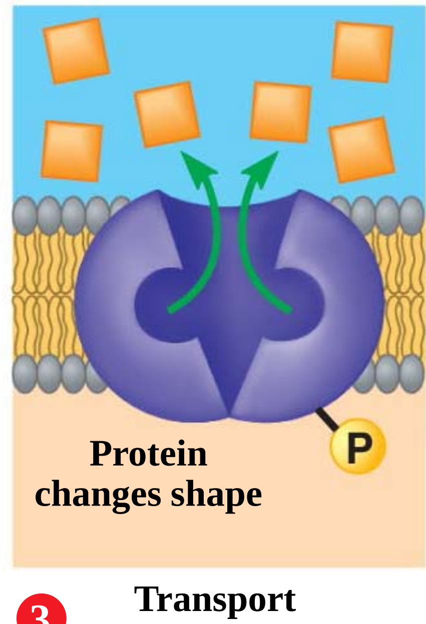


Active Transport

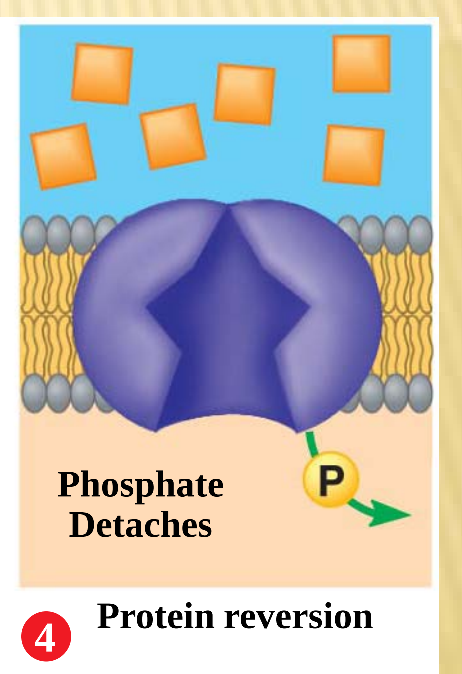
- Requires energy or ATP
- Moves solute from LOW to HIGH concentration AGAINST concentration gradient.
- The mechanism alters the shape of the membrane protein through phosphorylation using ATP.











Active transport of a solute across a membrane

Moving the "Big Stuff"

Exocytosis and endocytosis transport large molecules across membranes

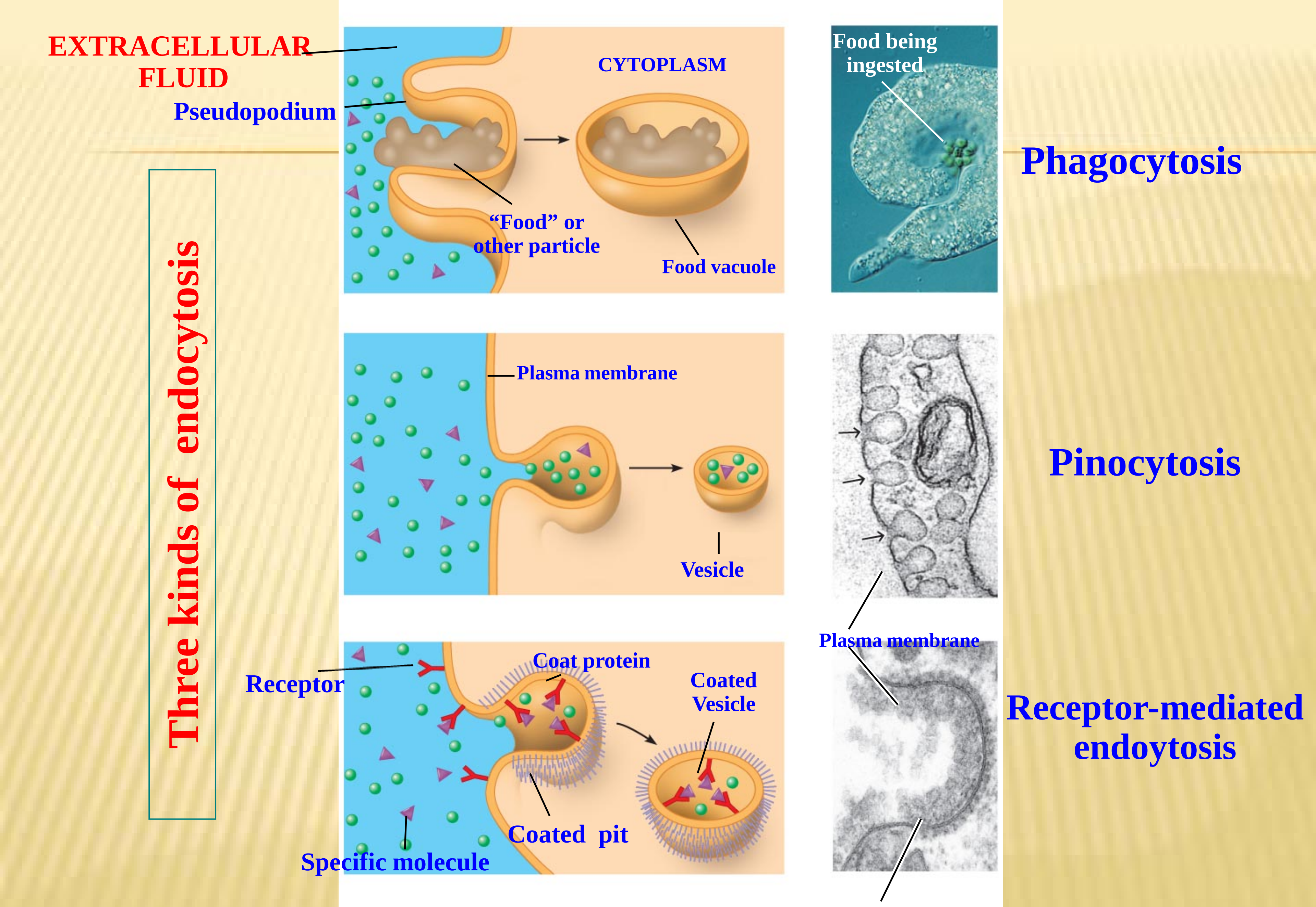
- **A cell uses two mechanisms for moving large molecules across membranes**
  - **Exocytosis is used to export bulky molecules, such as proteins or polysaccharides**
  - **Endocytosis is used to import substances useful to the livelihood of the cell**
- **In both cases, material to be transported is packaged within a vesicle that fuses with the membrane**

- **There are three kinds of endocytosis**

1. **Phagocytosis is the engulfment of a particle by wrapping cell membrane around it, forming a vacuole**

2. **Pinocytosis is the same thing except that fluids are taken into small vesicles**

3. **Receptor-mediated endocytosis is where receptors in a receptor-coated pit interact with a specific protein, initiating formation of a vesicle**

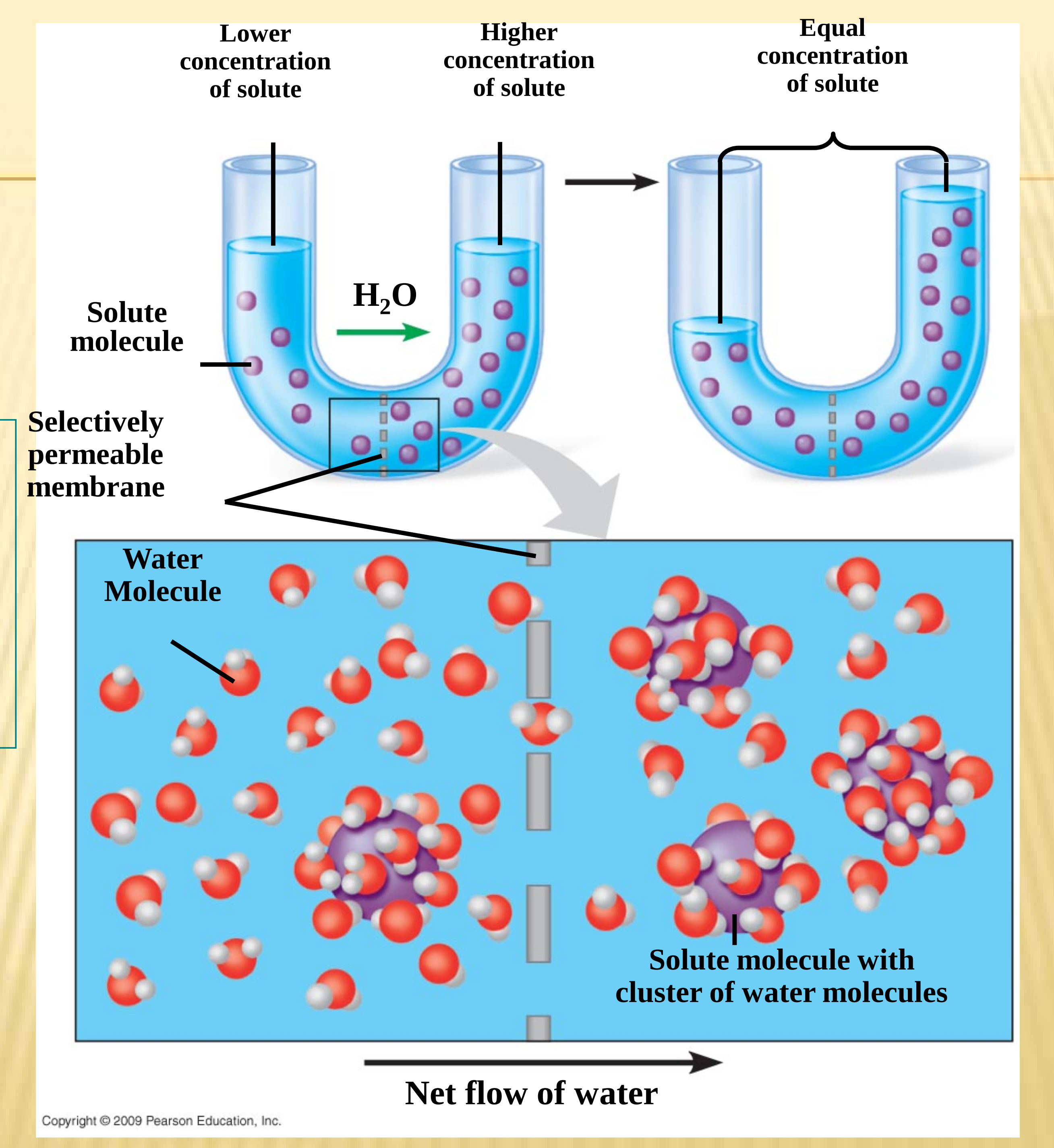

EXTRACELLULAR FLUID
Pseudopodium
CYTOPLASM
"Food" or other particle
Food vacuole
Food being ingested
Phagocytosis
Three kinds of endocytosis
Plasma membrane
Vesicle
Pinocytosis
Plasma membrane
Receptor
Coat protein
Coated Vesicle
Coated pit
Specific molecule
Receptor-mediated endoytosis
Material bound to receptor proteins
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Osmosis: Osmosis is the diffusion of water across a membrane

- **Osmosis will move water across a membrane down its concentration gradient until the concentration of solute is equal on both sides of the membrane (equilibrium).**

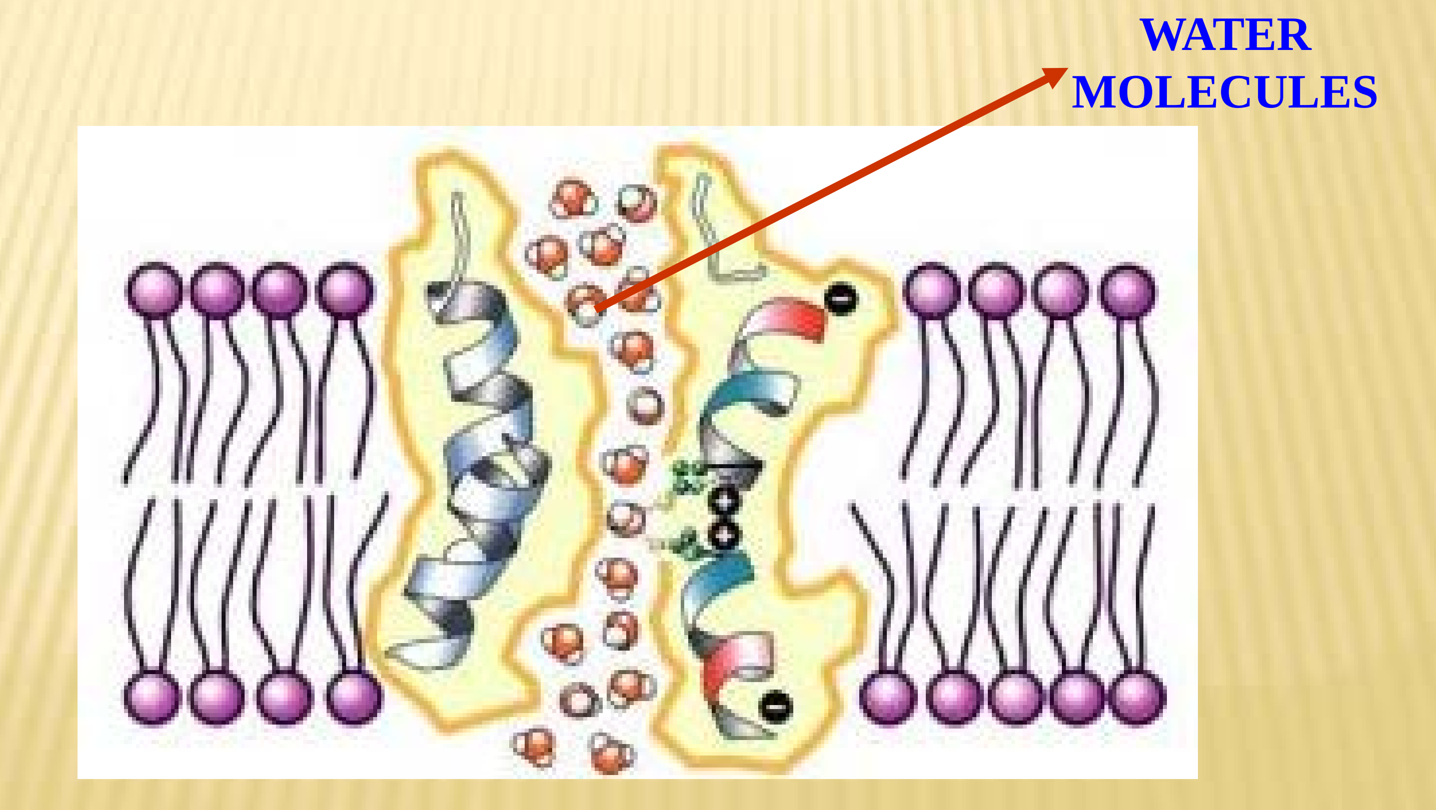
- **Moves from HIGH water potential (low solute) to LOW water potential (high solute)**

Osmosis, the diffusion of water across a membrane



Aquaporins

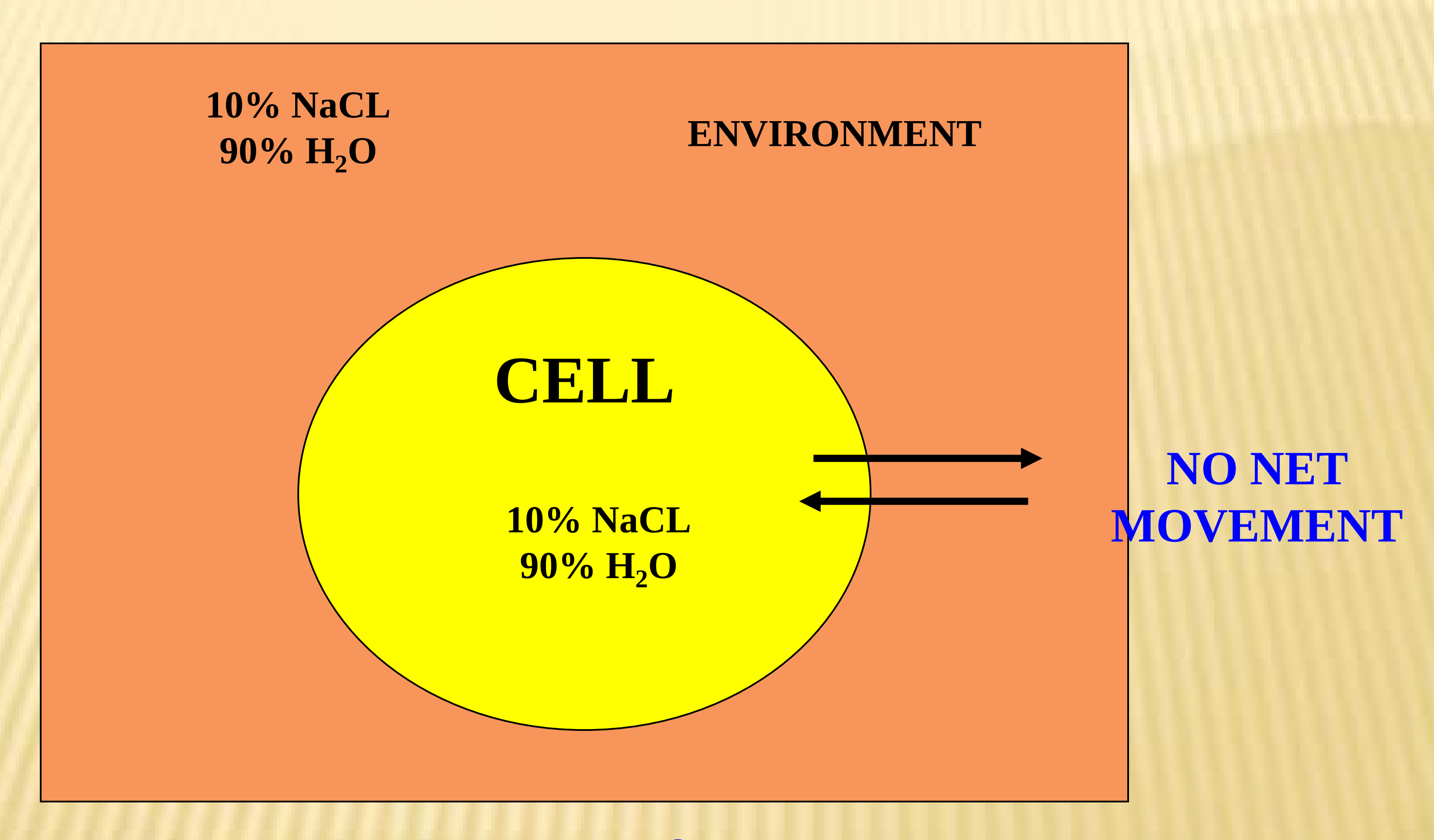
- Water Channels
- Protein pores used during OSMOSIS



Water balance between cells and their surroundings is crucial to organisms

- **Tonicity** is a term that describes the ability of a solution to cause a cell to gain or lose water
  - Tonicity is dependent on the concentration of a non-penetrating solute on both sides of the membrane
    - **Isotonic** indicates that the concentration of a solute is the same on both sides
    - **Hypertonic** indicates that the concentration of solute is higher **outside** the cell
    - **Hypotonic** indicates a higher concentration of solute **inside** the cell

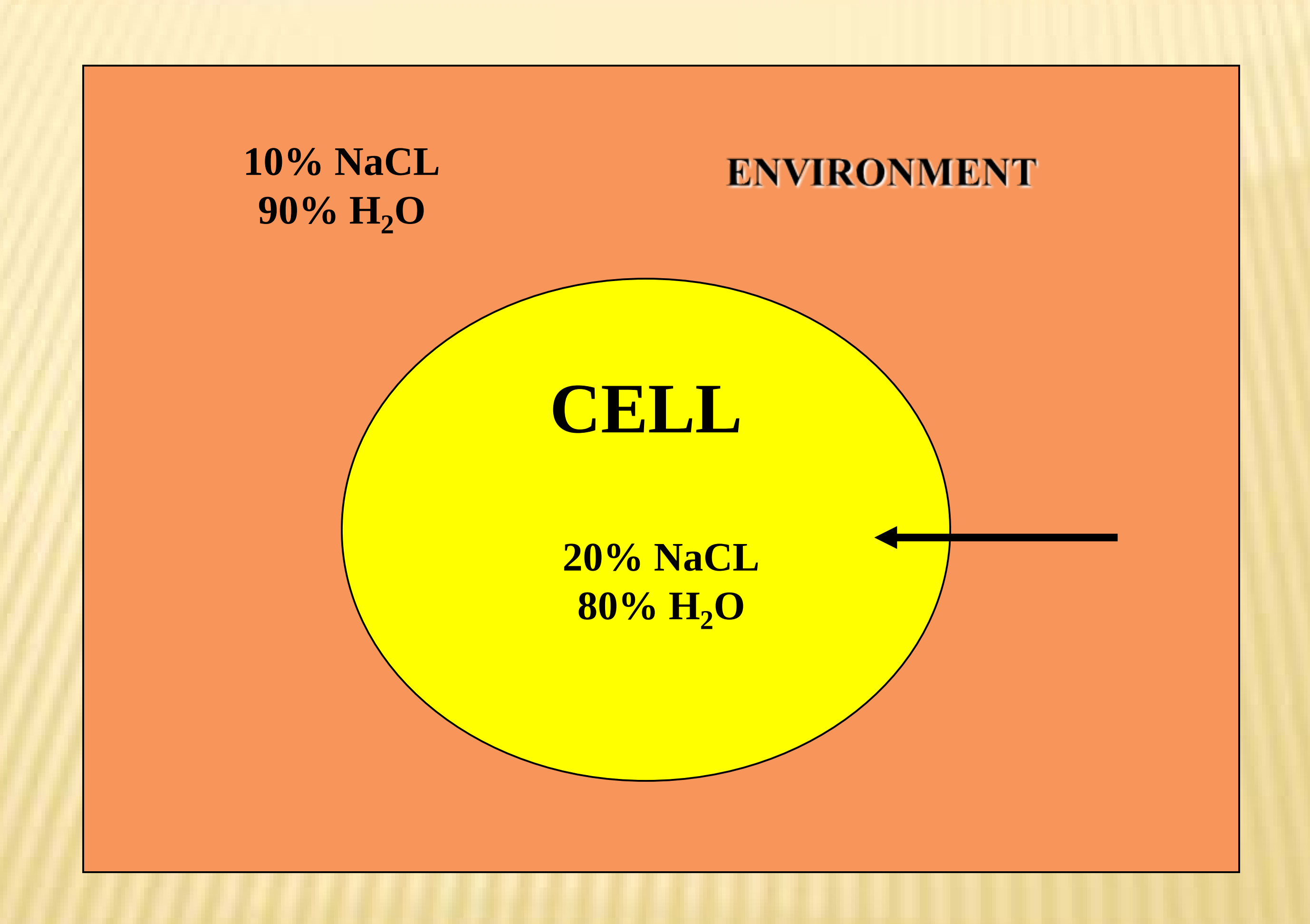
Cell in Isotonic Solution



What is the direction of water movement?

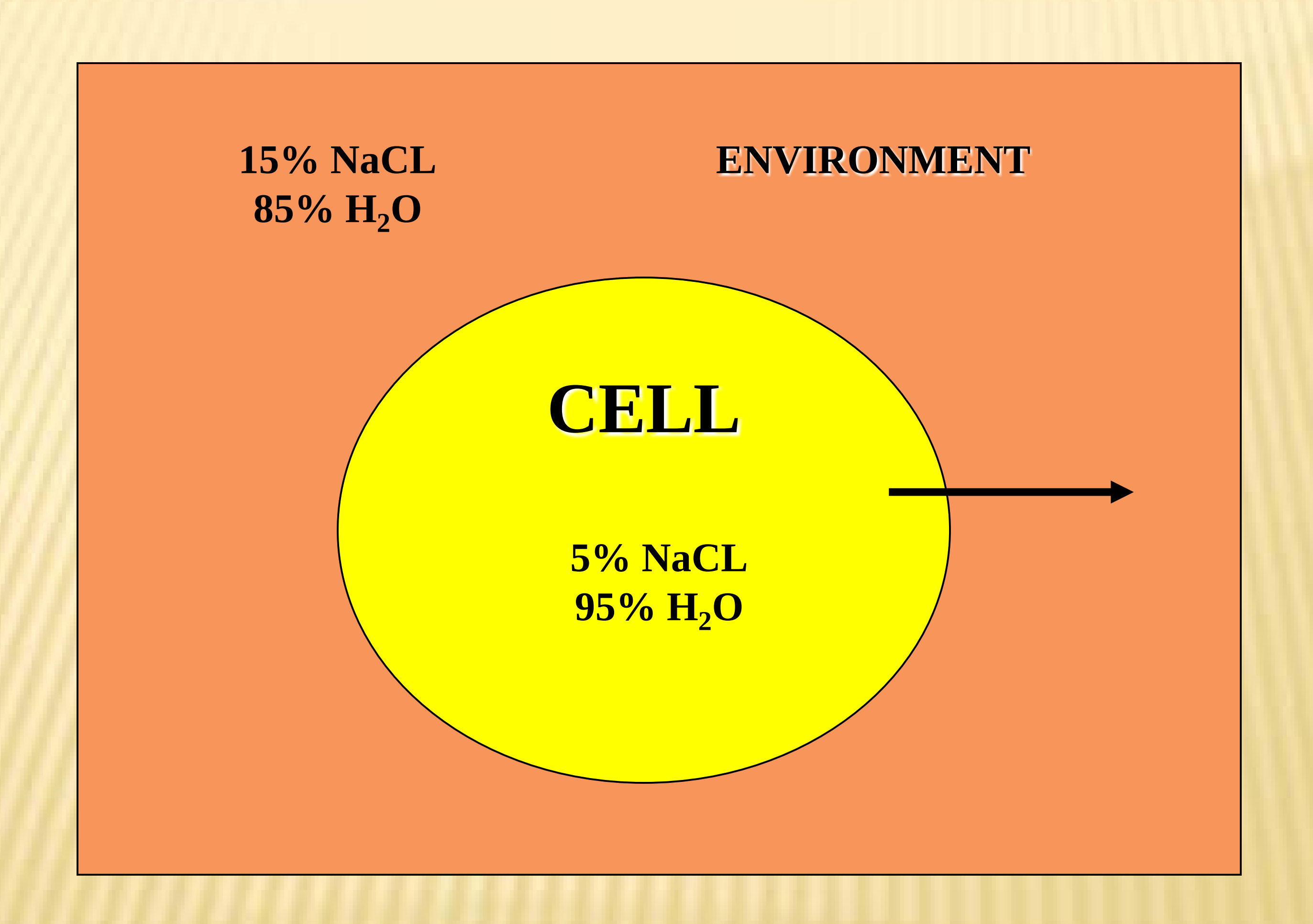
The cell is at equilibrium.

Cell in Hypotonic Solution

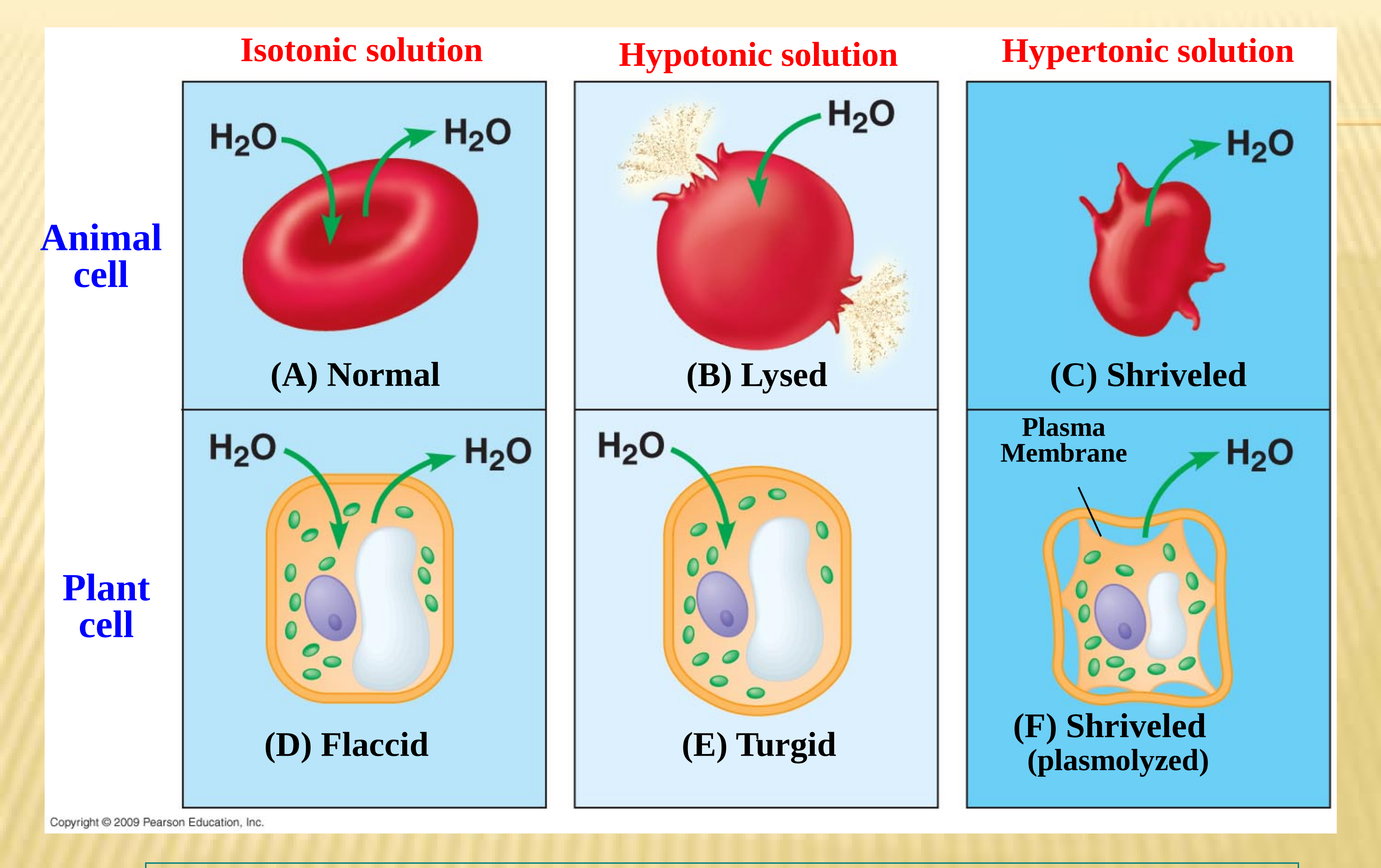


What is the direction of water movement?

Cell in Hypertonic Solution



What is the direction of water movement?



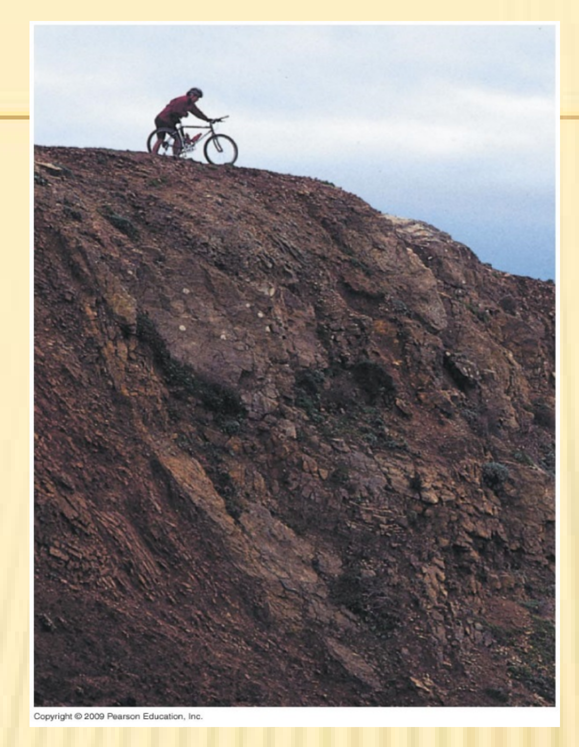
How animal and plant cells behave in different solutions

ENERGY AND THE CELL

Cells transform energy as they perform work

- **Cells are small units, a chemical factory, housing thousands of chemical reactions**
  - **The result of reactions is maintenance of the cell, manufacture of cellular parts and replication**
- **Energy is the capacity to do work and cause change**
  - **There are two kinds of energy**
    - **A. Kinetic energy is the energy of motion, Heat and light energy are examples**
    - **B. Potential energy is energy that an object possesses as a result of its position , includes energy stored in chemical bonds**







Kinetic energy,
the energy of motion

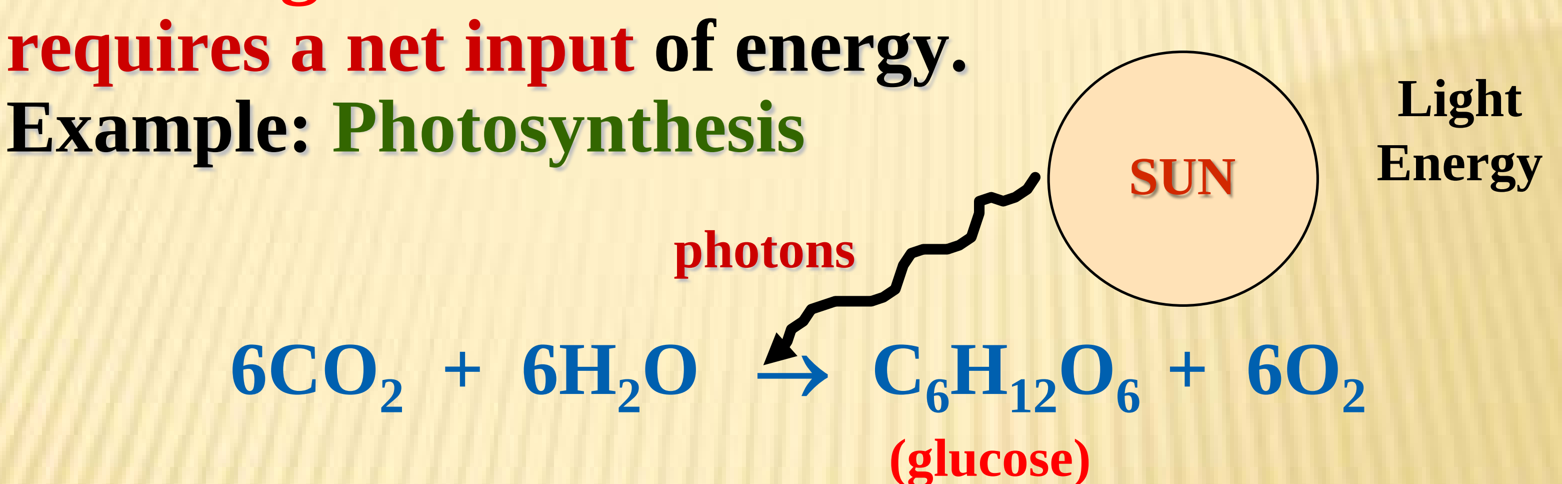
Potential energy,
stored energy as
a result of location
or structure

Potential energy being
converted to kinetic
energy

Two Types of Energy Reactions

1. Endergonic Reactions: **Chemical reaction that requires a net input of energy.**

Example: Photosynthesis



$$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$$

(glucose)

2. Exergonic Reactions:

Chemical reactions that releases energy

Example: Cellular Respiration

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{ATP}$$

Metabolic Reactions of Cells

What is Metabolism?

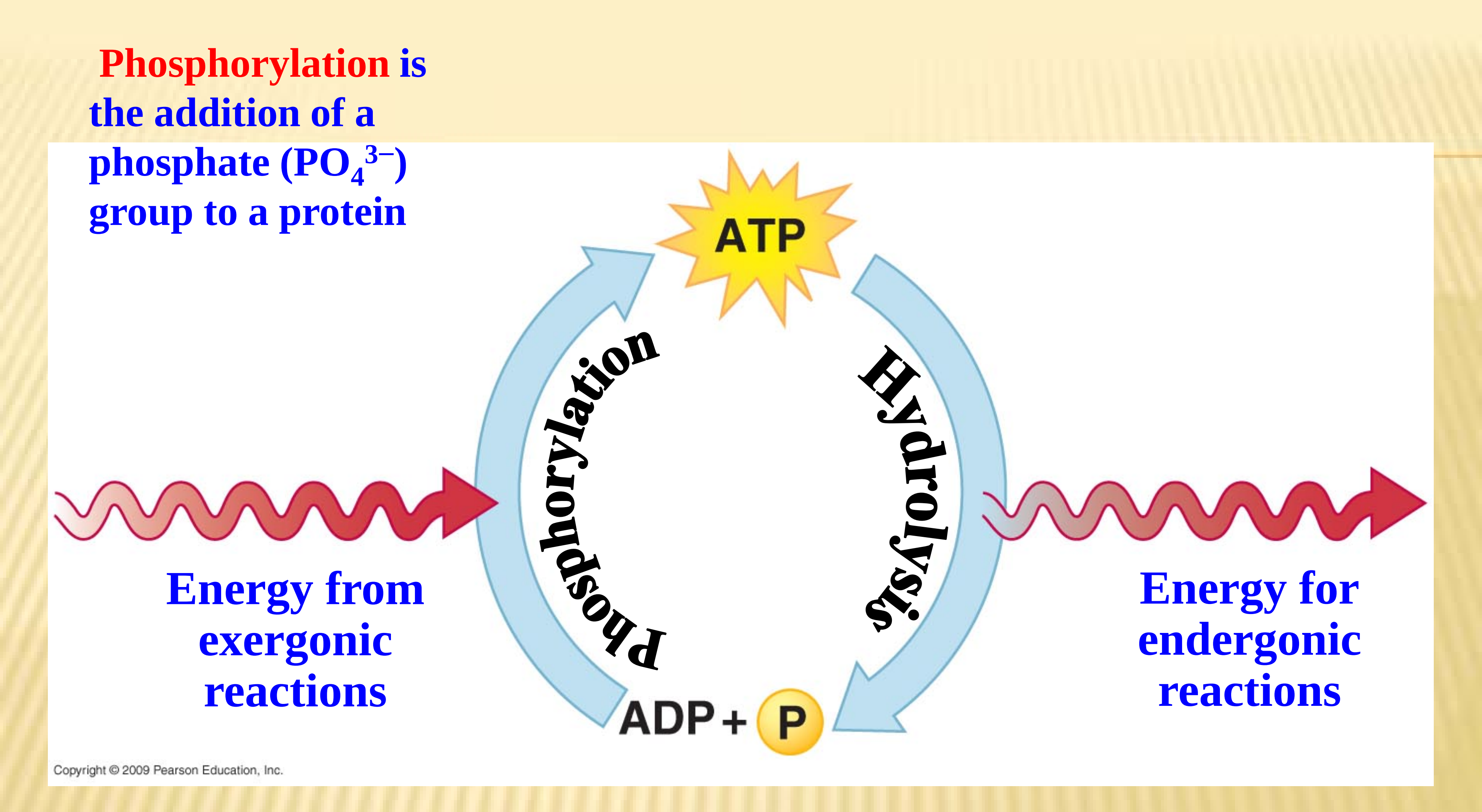
- **The sum total of the chemical activities of all cells.**
- *Two Types of Metabolism*

1) **Anabolic Pathways. Metabolic reactions, which consume energy (endergonic), to build complicated molecules from simpler compounds.**

2) **Catabolic Pathways. Metabolic reactions which release energy (exergonic) by breaking down complex molecules in simpler compounds**

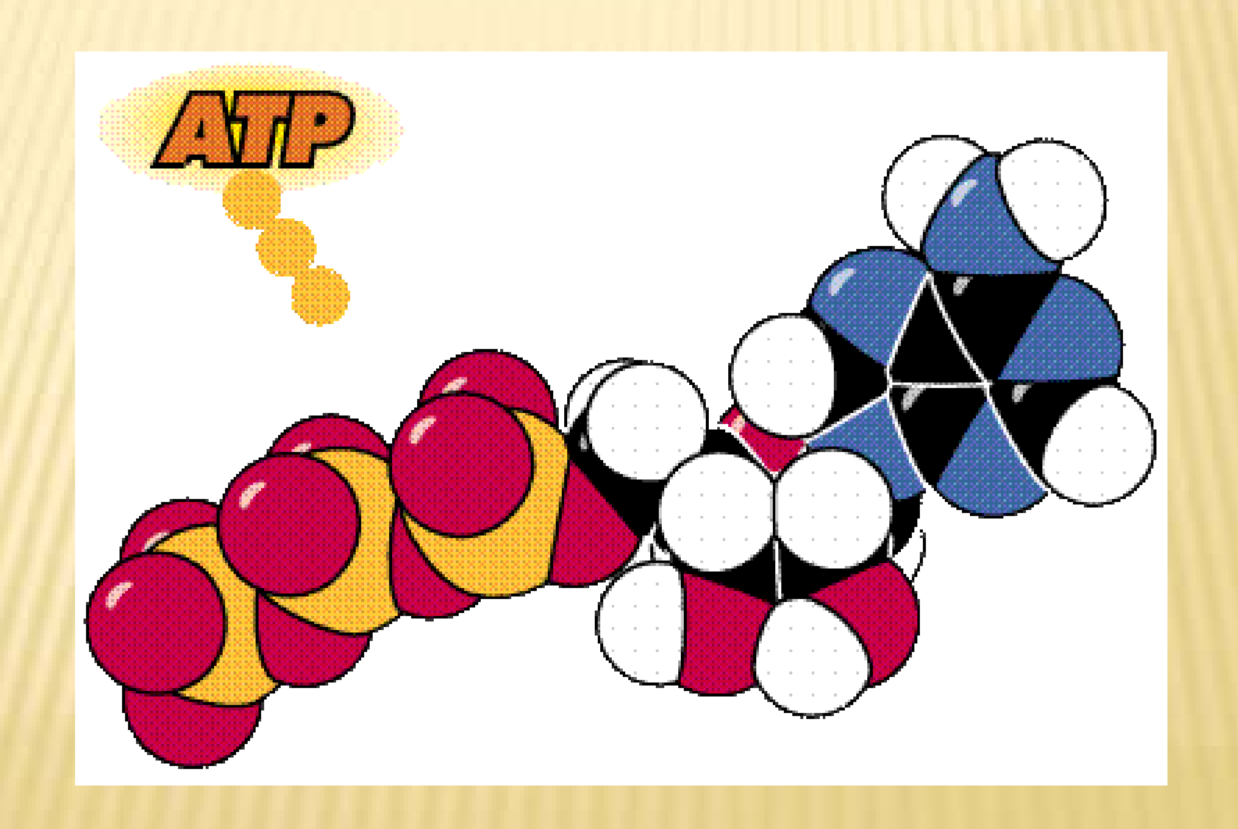
Chemical reactions either release or store energy

- **A cell does three main types of cellular work**
  - **Chemical work — driving endergonic reactions**
  - **Transport work — pumping substances across membranes**
  - **Mechanical work — beating of cilia**
- **To accomplish work, a cell must manage its energy resources, and it does so by energy coupling — the use of exergonic processes to drive an endergonic one**



The ATP cycle

Cellular Energy - ATP

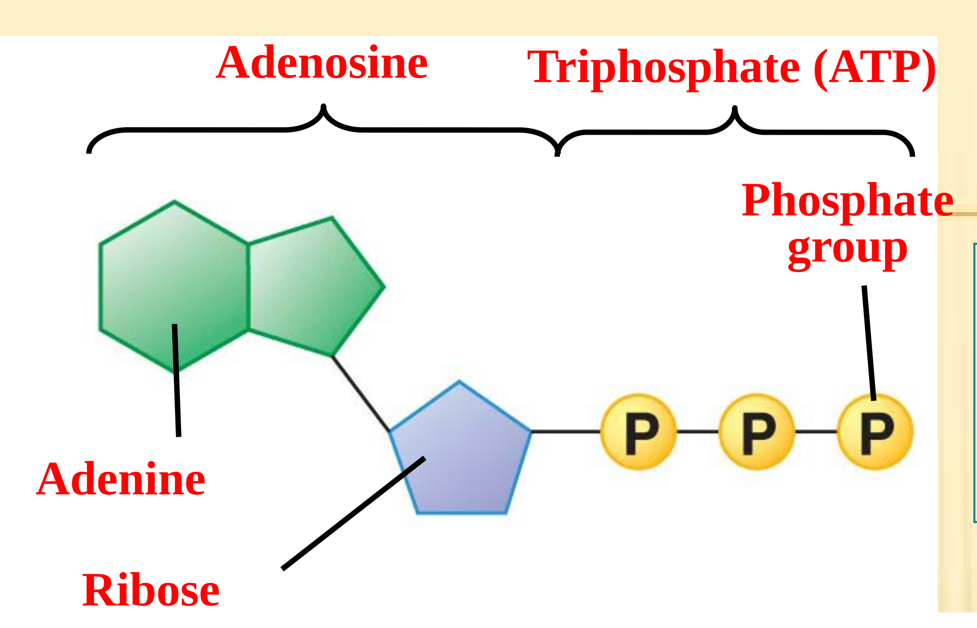


ATP shuttles chemical energy and drives cellular work

- **ATP, adenosine triphosphate, is the energy currency of cells.**
  - **ATP is the immediate source of energy that powers most forms of cellular work.**
  - **It is composed of adenine (a nitrogenous base), ribose (a five-carbon sugar), and three phosphate groups.**

ATP shuttles chemical energy and drives cellular work

- **Hydrolysis of ATP releases energy by transferring its third phosphate from ATP to some other molecule**
  - **The transfer is called phosphorylation**
  - **In the process, ATP energizes molecules**



The structure and hydrolysis of ATP. The reaction of ATP and water yields ADP, a phosphate group, and energy

Hydrolysis

H_2O

P P + P + Energy

Adenosine Diphosphate → (ADP)

Enzymes speed up the cell's chemical reactions

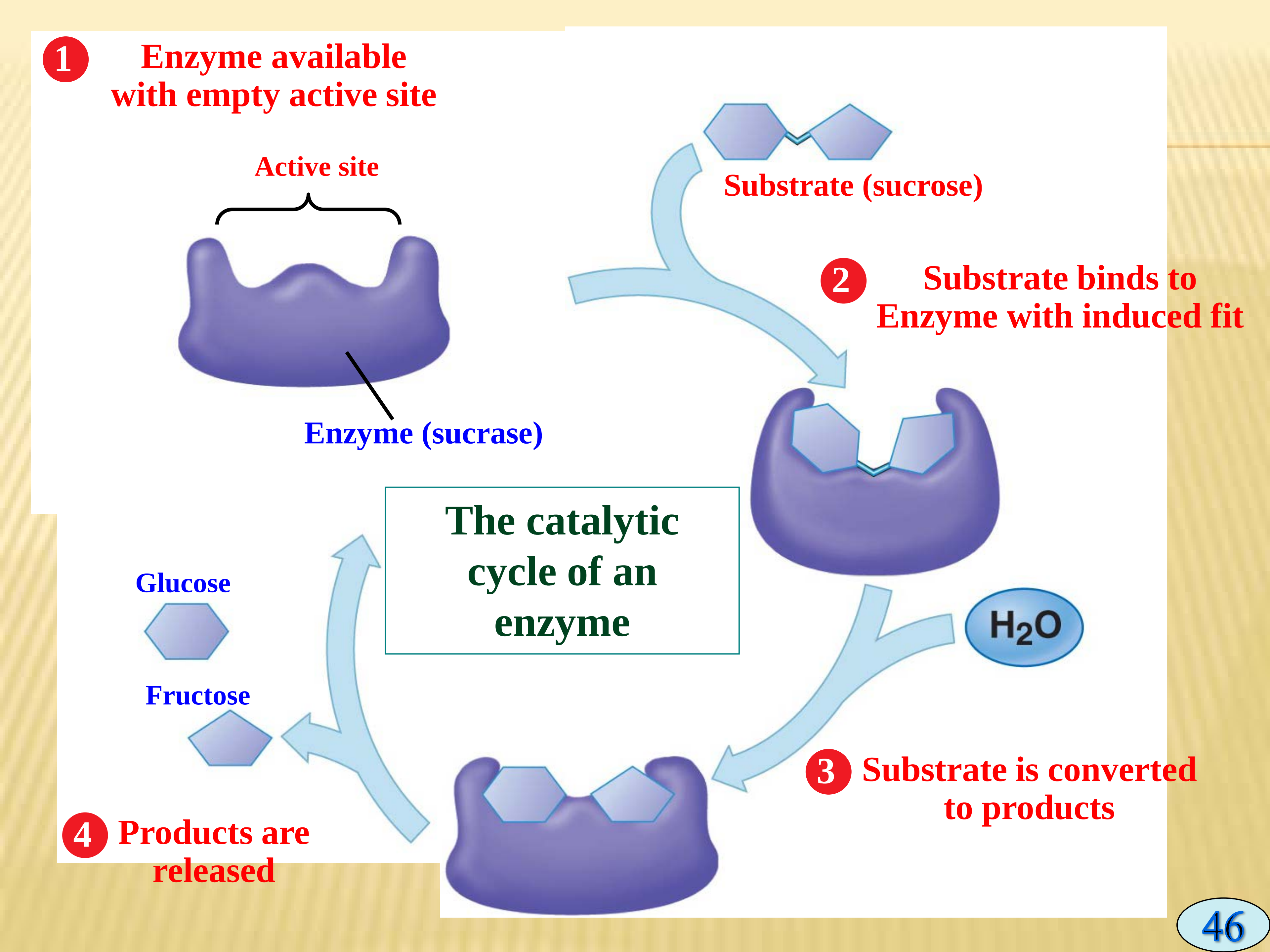
- **The cell uses catalysis to drive (speed up) biological reactions**
  - **Catalysis is accomplished by enzymes, which are proteins that function as biological catalysts**
- **Enzyme increases speed of a chemical reaction without being consumed**
  - **Each enzyme is specific, has a particular target molecule called the substrate**

A specific enzyme catalyzes each cellular reaction

- **Enzymes have unique three-dimensional shapes**

The shape is critical to their role as biological catalysts.

- **As a result of its shape, the enzyme has an active site where the enzyme interacts with the enzyme's substrate.**
- **Consequently, the substrate's chemistry is altered to form the product of the enzyme reaction.**



1 Enzyme available with empty active site
Active site
Enzyme (sucrase)
Substrate (sucrose)
2 Substrate binds to Enzyme with induced fit
The catalytic cycle of an enzyme
H_2O
3 Substrate is converted to products
Glucose
Fructose
4 Products are released

A specific enzyme catalyzes each cellular reaction

- **For optimum activity, enzymes require certain environmental conditions**
  - **Temperature is very important, and optimally, human enzymes function best at 37ºC, or body temperature**
  - **High temperature will denature human enzymes**
  - **Enzymes also require a pH around neutrality for best results**

Enzymes helpers

- **Some enzymes require non-protein helpers**
  - **Cofactors are inorganic, such as zinc, iron, or copper**
  - **Coenzymes are organic molecules and are often vitamins**

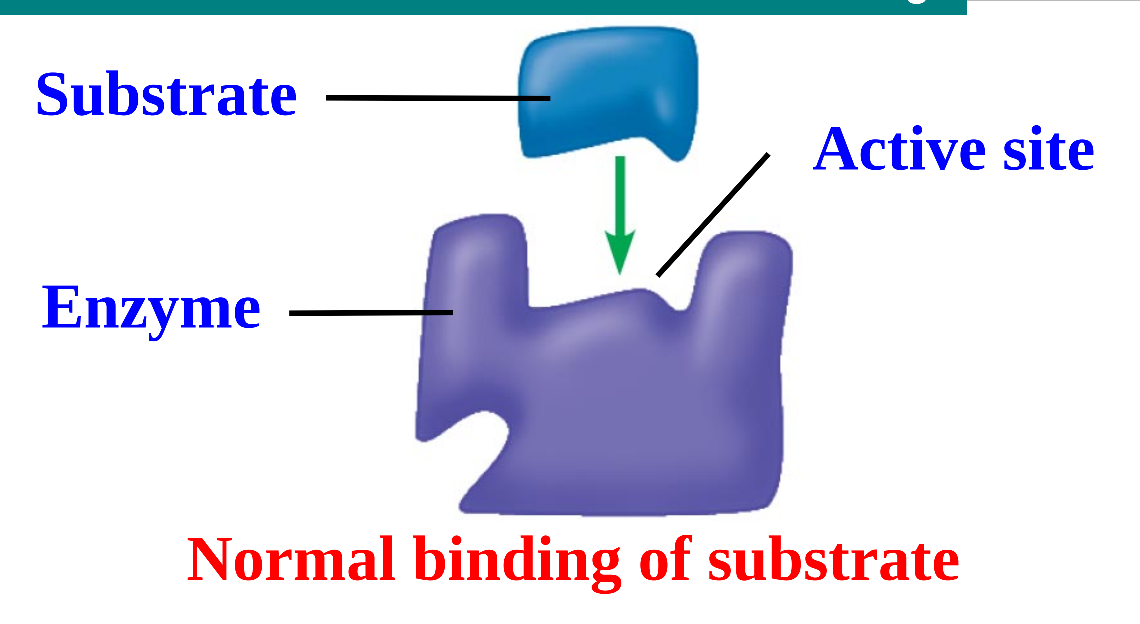
Competitive Inhibitors

- **Inhibitors are chemicals that inhibit an enzyme's activity**
  - **One group inhibits because they compete for the enzyme's active site and thus block substrates from entering the active site**
  - **These are called competitive inhibitors**

Noncompetitive Inhibitors

- Other inhibitors do not act directly with the active site
  - These bind somewhere else and change the shape of the enzyme so that the substrate will no longer fit the active site
  - These are called noncompetitive inhibitors

How inhibitors interfere with substrate binding



Competitive Inhibitor

Noncompetitive Inhibitor

Enzyme inhibition

Enzyme inhibitors

- **Enzyme inhibitors are important in regulating cell metabolism**
  - **Often the product of a metabolic pathway can serve as an inhibitor of one enzyme in the pathway, a mechanism called feedback inhibition**
  - **The more product formed, the greater the inhibition, and in this way, regulation of the pathway is accomplished**

How Cells Harvest Chemical Energy

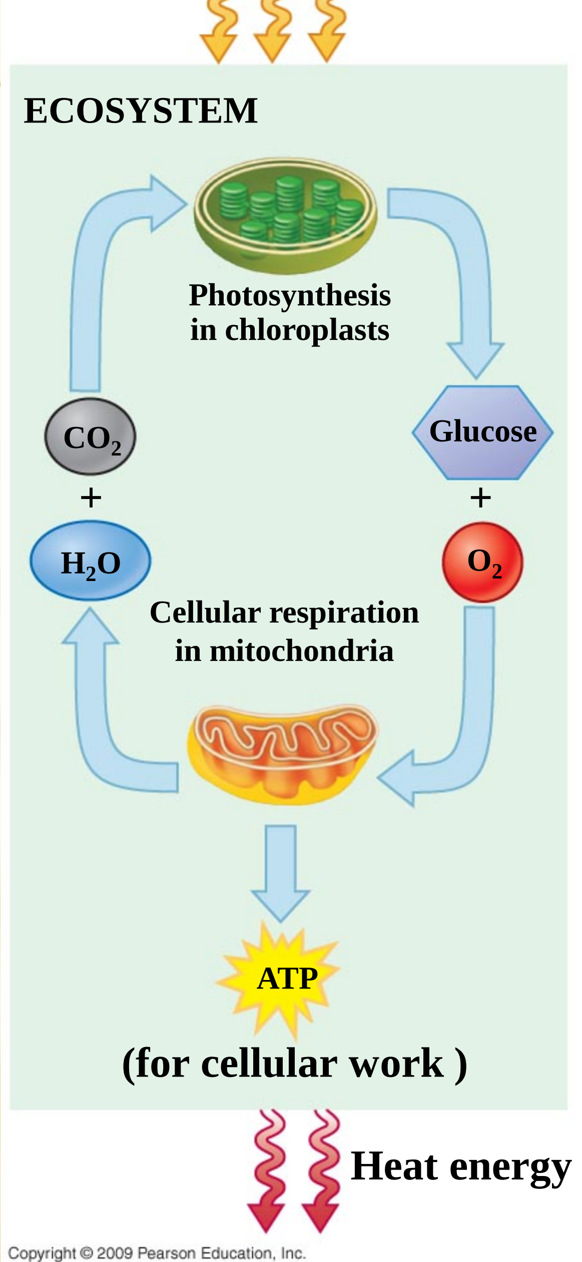
Harvest chemical energy (ATP)

- Energy is necessary for life processes. These include growth, transport, manufacture, movement, reproduction, and others.
- Energy that supports life on Earth is captured from sun rays reaching Earth through plant, algae, protist, and bacterial photosynthesis.
- All of our cells harvest chemical energy (ATP) from our food by a process called cellular respiration

Photosynthesis and cellular respiration provide energy for life

- Energy in sunlight is used in photosynthesis to make glucose from CO_2 and H_2O with release of O_2
- Other organisms use the O_2 and energy in sugar and release CO_2 and H_2O (cellular respiration)
- Together, these two processes are responsible for the majority of life on Earth

The connection between photosynthesis and cellular respiration

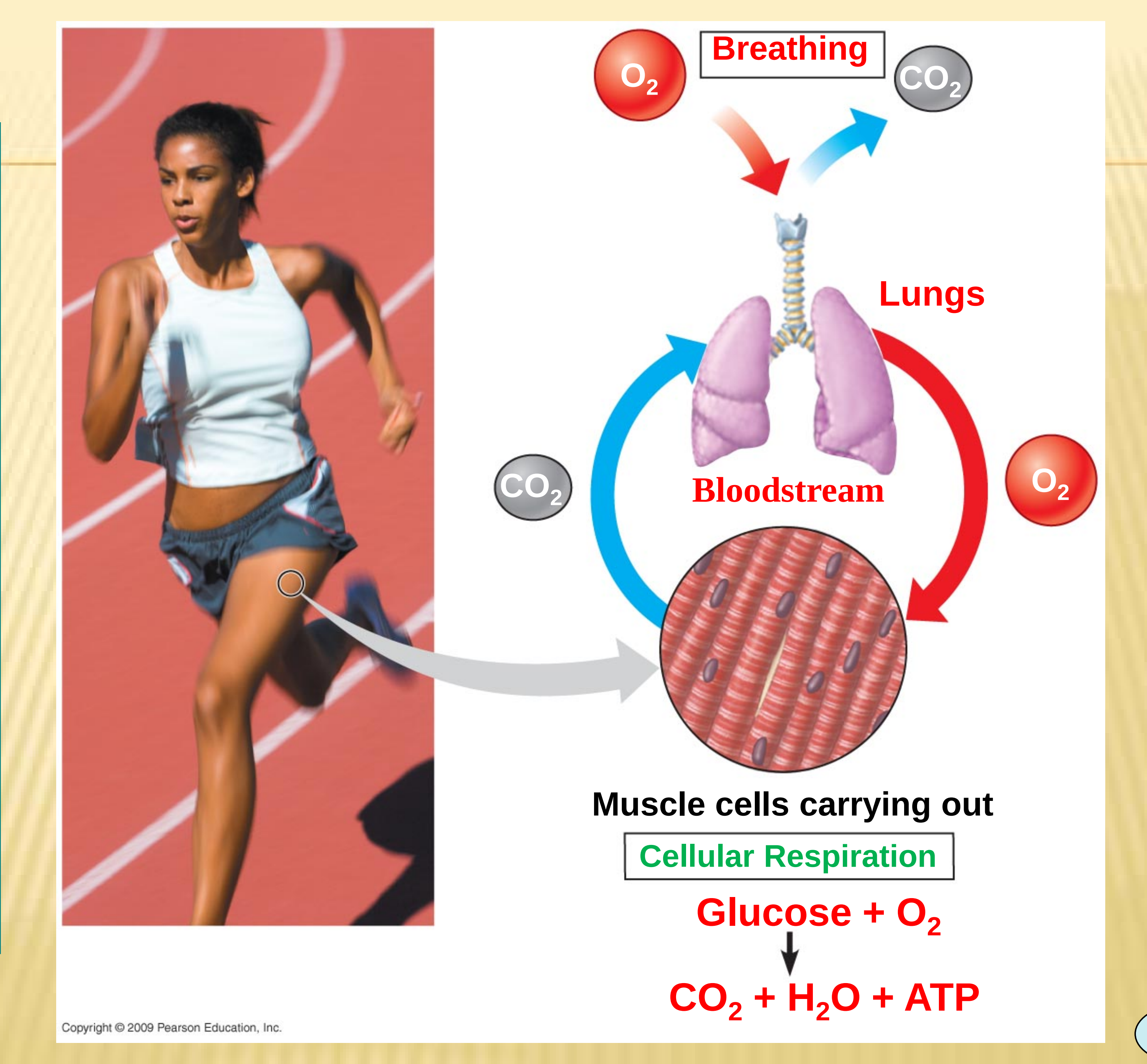


INTRODUCTION TO CELLULAR RESPIRATION

Breathing supplies oxygen to our cells for use in cellular respiration and removes carbon dioxide

- **Breathing and cellular respiration are closely related**
  - **Breathing is necessary for exchange of CO_2 produced during cellular respiration for atmospheric O_2**
  - **Cellular respiration uses O_2 to help harvest energy from glucose and produces CO_2 in the process**

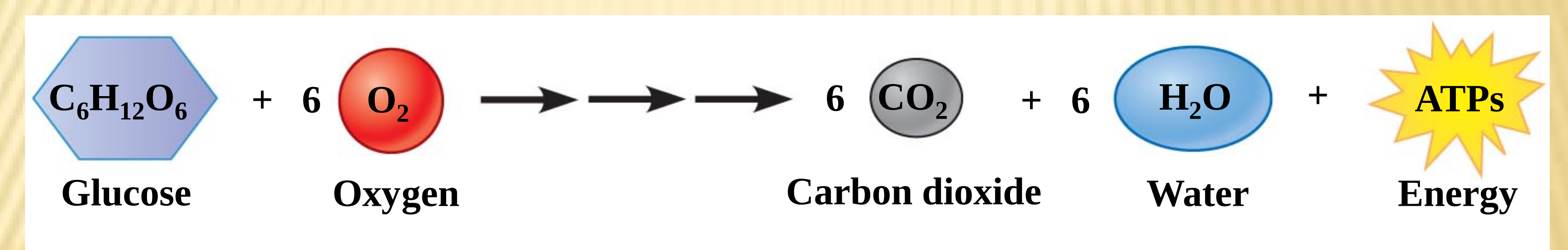
The connection between breathing and cellular respiration



Cellular respiration banks energy in ATP molecules

- **Cellular respiration is an exergonic process that transfers energy stored in glucose bonds to ATP**
  - **Cellular respiration produces 38 ATP molecules from each glucose molecule**
  - **Other foods (protein and lipid) can be used as a source of energy as well**

Summary equation for cellular respiration



How do cells extract energy in chemical bonds in the organic molecules (food)

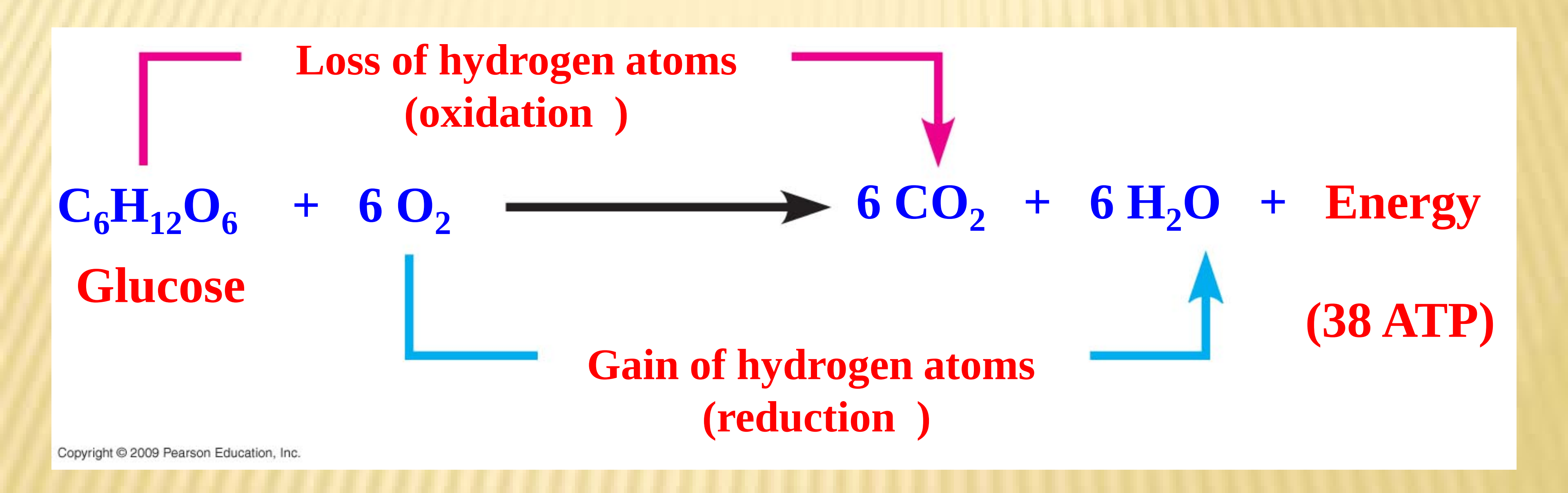
How do cells extract energy in chemical bonds in organic molecules

- **The energy necessary for life is contained in the arrangement of electrons in chemical bonds in organic molecules**
- **When the carbon-hydrogen bonds of glucose are broken, electrons are transferred to oxygen**
  - **Oxygen has a strong tendency to attract electrons**

How do cells extract energy in chemical bonds in organic molecules

- **A cellular respiration equation is helpful to show the changes in hydrogen atom distribution**
  - **Glucose loses its hydrogen atoms and is ultimately converted to CO_2**
  - **At the same time, O_2 gains hydrogen atoms and is converted to H_2O**
    - **Loss of electrons is called oxidation**
    - **Gain of electrons is called reduction**

Rearrangement of hydrogen atoms (with their electrons) in the redox reactions (Reduction & Oxidation) of cellular respiration

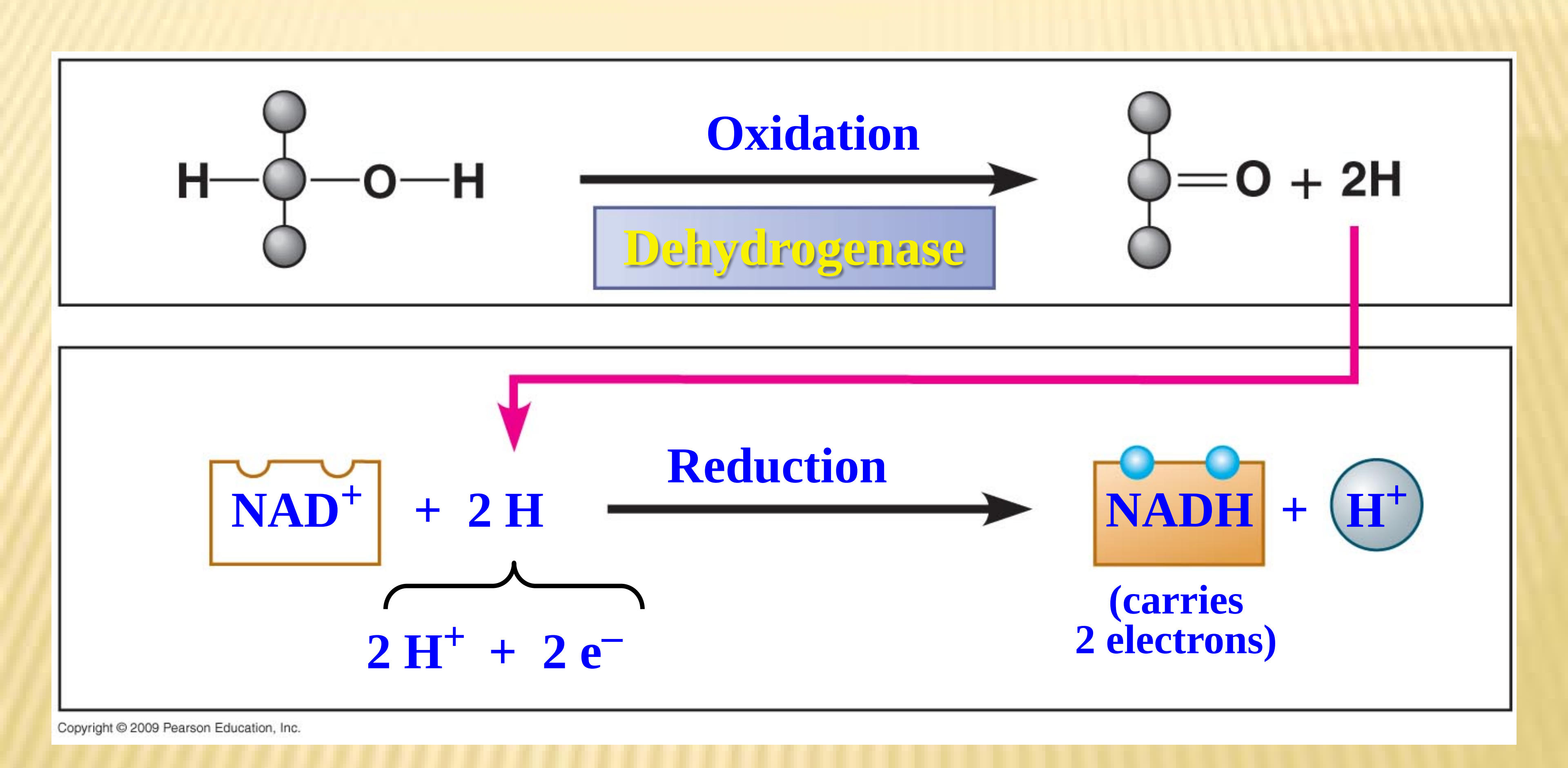


Redox (Reduction & Oxidation) reactions

How do cells extract energy in chemical bonds in organic molecules

- **Enzymes are necessary to oxidize glucose and other foods**
  - **The enzyme that removes hydrogen from an organic molecule is called dehydrogenase**
  - **Dehydrogenase requires a coenzyme called NAD^+ (nicotinamide adenine dinucleotide) to shuttle electrons**
  - **NAD^+ can become reduced when it accepts electrons and oxidized when it gives them up**

A pair of redox reactions, occurring simultaneously

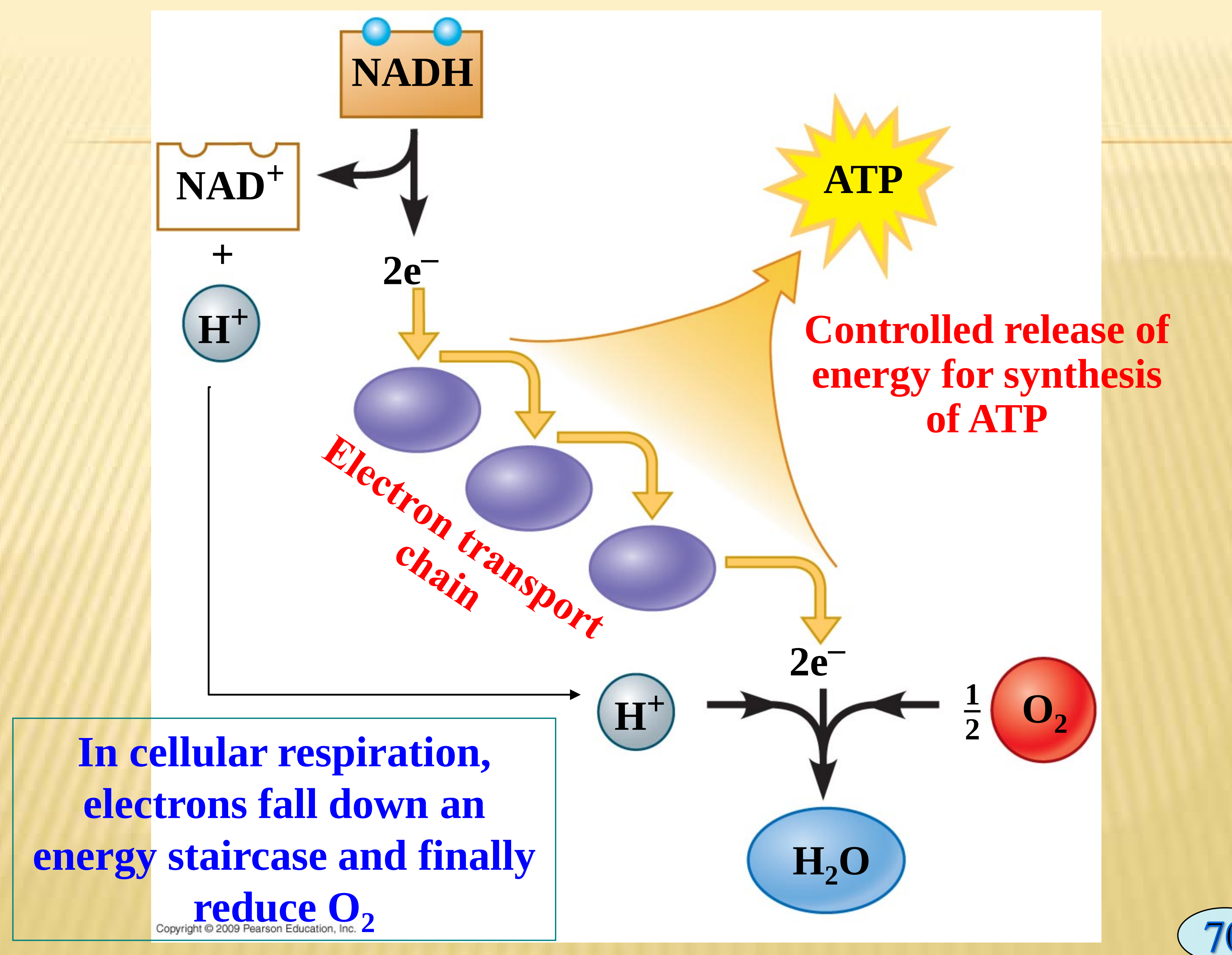


Cells tap energy from electrons "falling" from organic fuels to oxygen

- **The transfer of electrons to NAD^+ results in the formation of NADH, the reduced form of NAD^+**
  - **In this situation, NAD^+ is called an electron acceptor, but it eventually becomes oxidized (loses an electron) and is then called an electron donor**

Cells tap energy from electrons “falling” from organic fuels to oxygen

- **There are other electron “carrier” molecules that function like NAD^+**
  - **They form a staircase where the electrons pass from one to the next down the staircase**
  - **These electron carriers collectively are called the electron transport chain, and as electrons are transported down the chain, ATP is generated**


NADH
NAD+
+
H+
2e−
ATP
Controlled release of energy for synthesis of ATP
Electron transport chain
2e−
H+
1/2
O2
H2O
In cellular respiration, electrons fall down an energy staircase and finally reduce O2
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Stages of Aerobic Cellular Respiration

What are the Stages of Cellular Respiration?

1. Glycolysis occurs in the Cytoplasm

2. The Krebs Cycle or citric acid cycle occurs in the mitochondria matrix

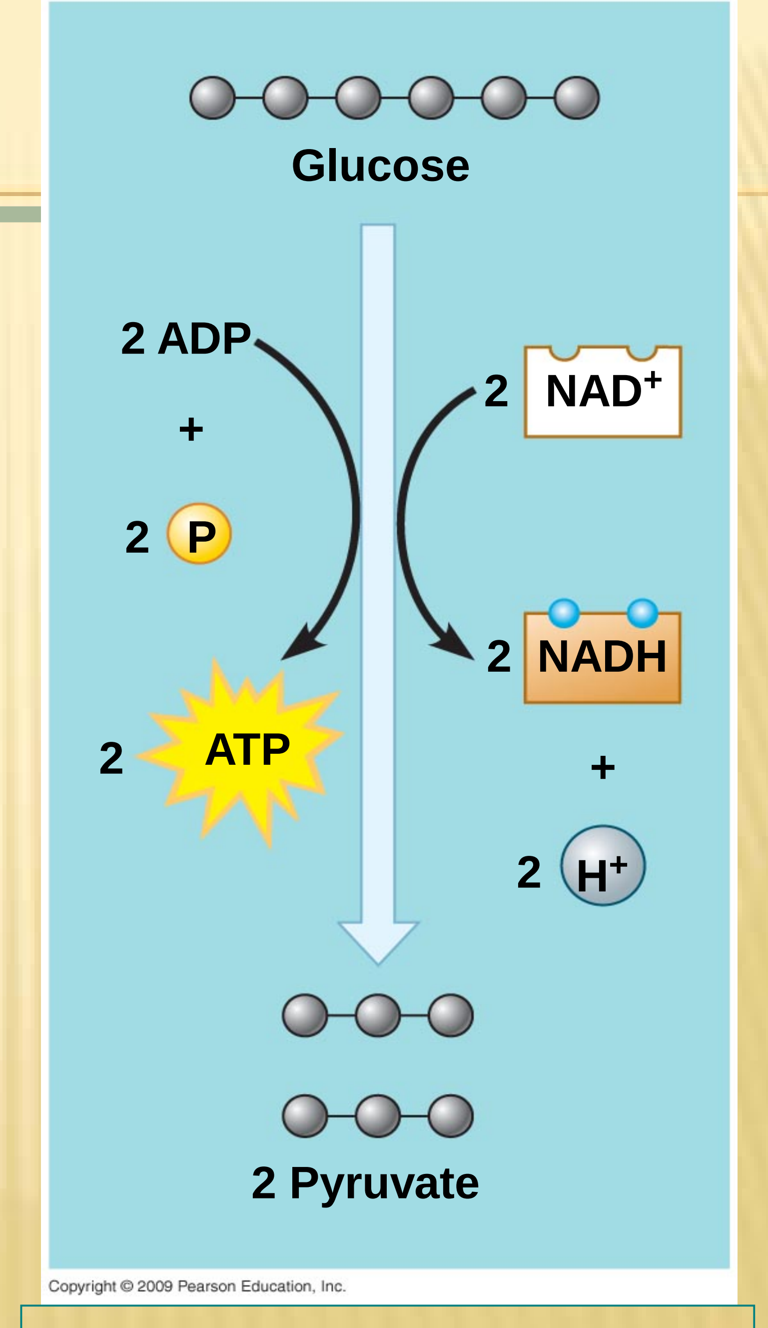
3. Oxidation phosphorylation or The Electron Transport Chain occurs in the mitochondria inner membrane

- **Stage 1: Glycolysis**
  - **Glycolysis begins respiration by breaking glucose, a six-carbon molecule, into two molecules of a three-carbon compound called pyruvate**
  - **This stage occurs in the cytoplasm**

Glucose
C-C-C-C-C-C
Glycolysis
In Cytoplasm
C-C-C C-C-C
Pyruvate Pyruvate

Glycolysis harvests chemical energy by oxidizing glucose to pyruvate

- In glycolysis, a single molecule of glucose is enzymatically cut in half through a series of steps to produce two molecules of pyruvate
  - In the process, two molecules of NAD^+ are reduced to two molecules of NADH
  - At the same time, two molecules of ATP are produced by substrate-level phosphorylation



An overview of glycolysis

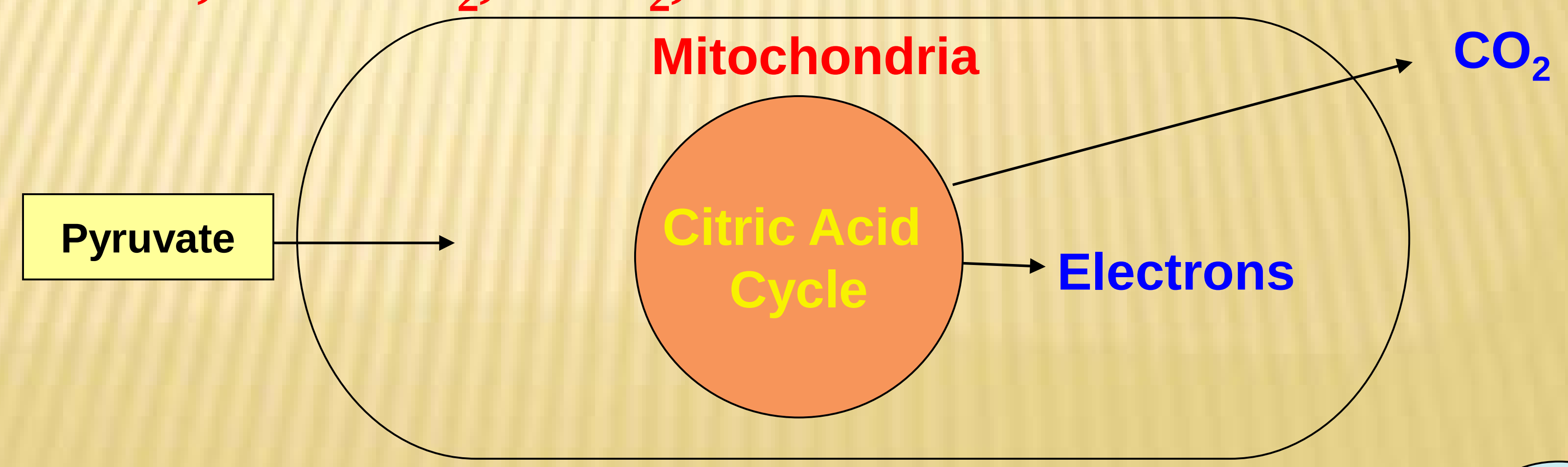
Stage 2: The citric acid cycle (Krebs Cycle) A Little Krebs Cycle History



- Discovered by Hans Krebs in 1937
- He received the Nobel Prize in physiology or medicine in 1953 for his discovery

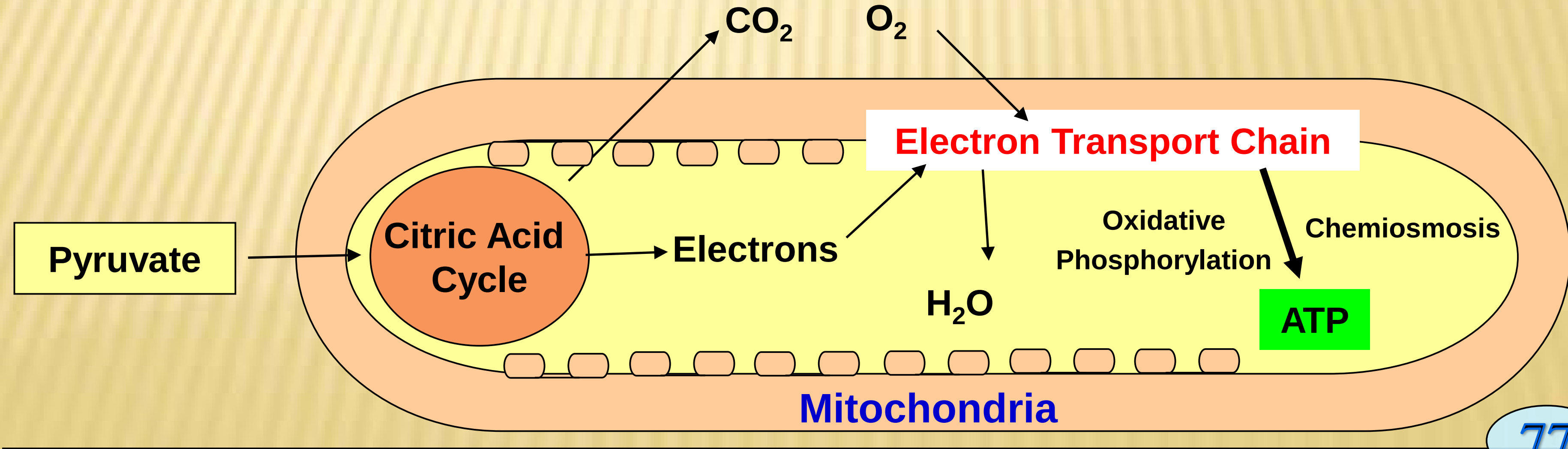
Overview Stage 2: The citric acid cycle

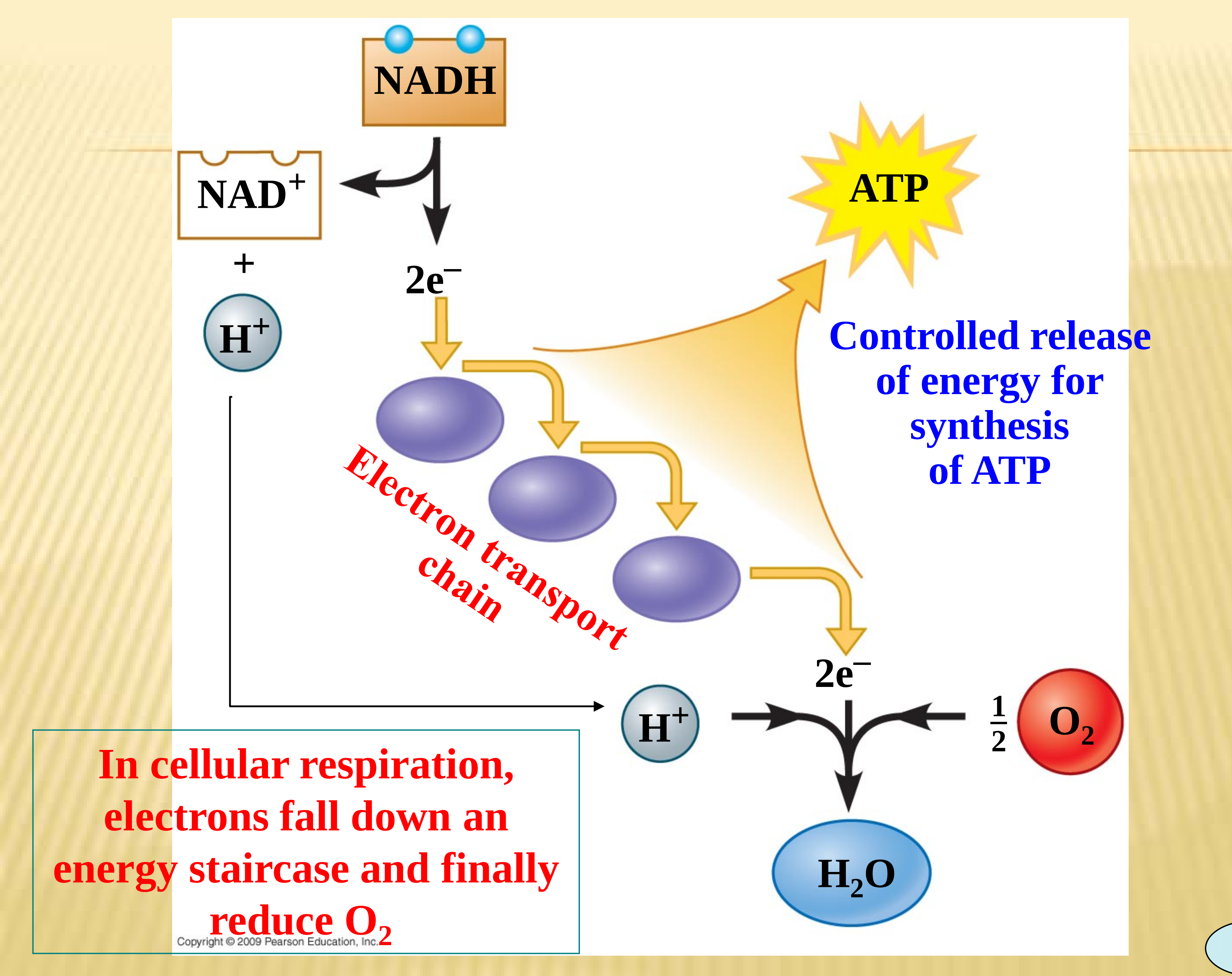
- **Stage 2: The citric acid cycle**
  - The citric acid cycle breaks down pyruvate into carbon dioxide and supplies the third stage **Oxidative phosphorylation** with electrons
  - This stage, **The citric acid cycle,** occurs in the mitochondria matrix
  - **For each Glucose molecule, the Krebs Cycle produces 6NADH, 2FADH$_2$, 4CO$_2$, and 2ATP**



Stage 3: Oxidative phosphorylation

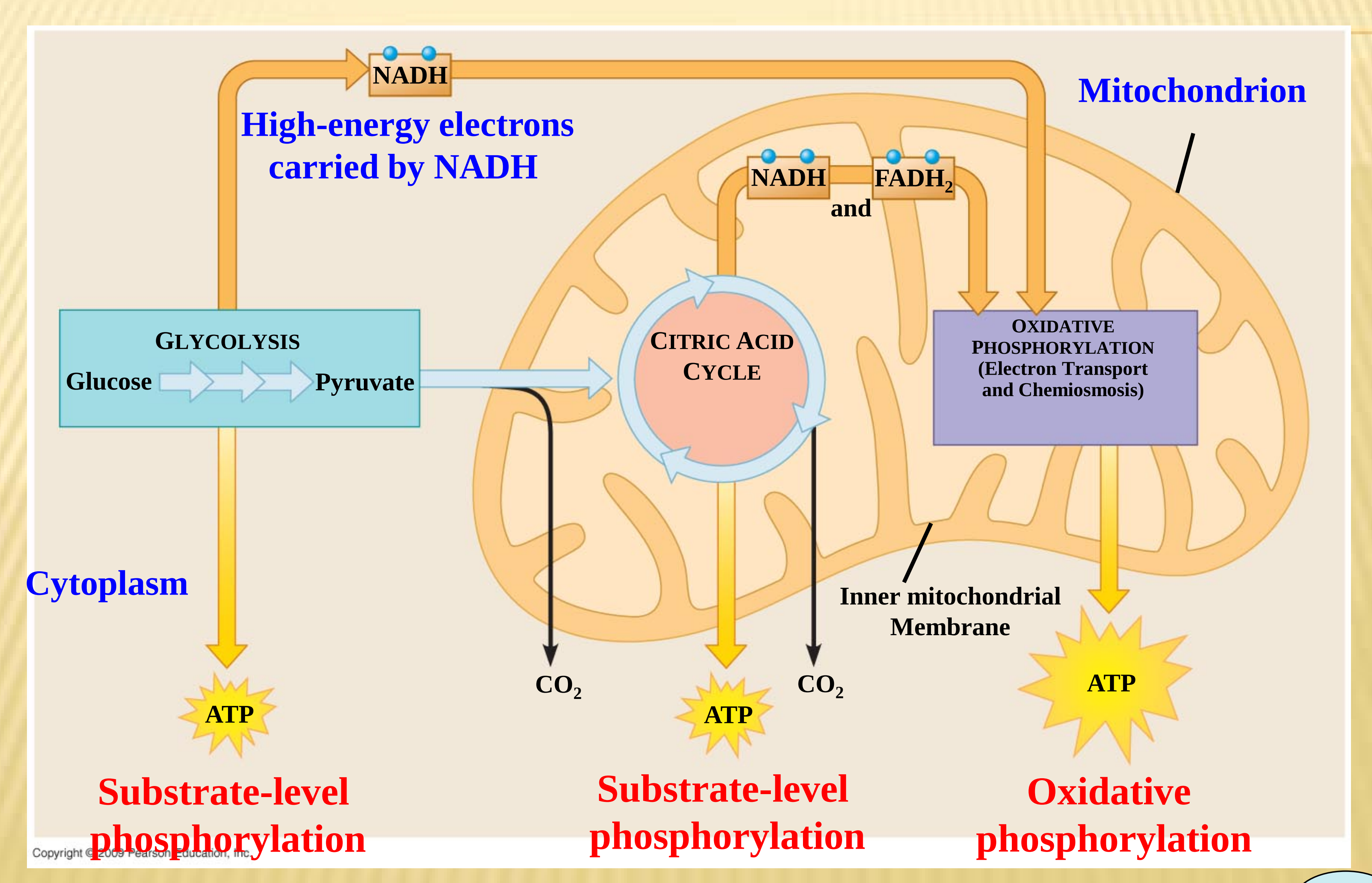
- At this stage, electrons are shuttled through the electron transport chain
- As a result, ATP is generated through **oxidative phosphorylation**
- (oxidation of NADH to NAD and phosphorylation of ADP to ATP)
- This stage Occurs Across Inner Mitochondrial membrane





In cellular respiration, electrons fall down an energy staircase and finally reduce O_2

An overview of cellular respiration



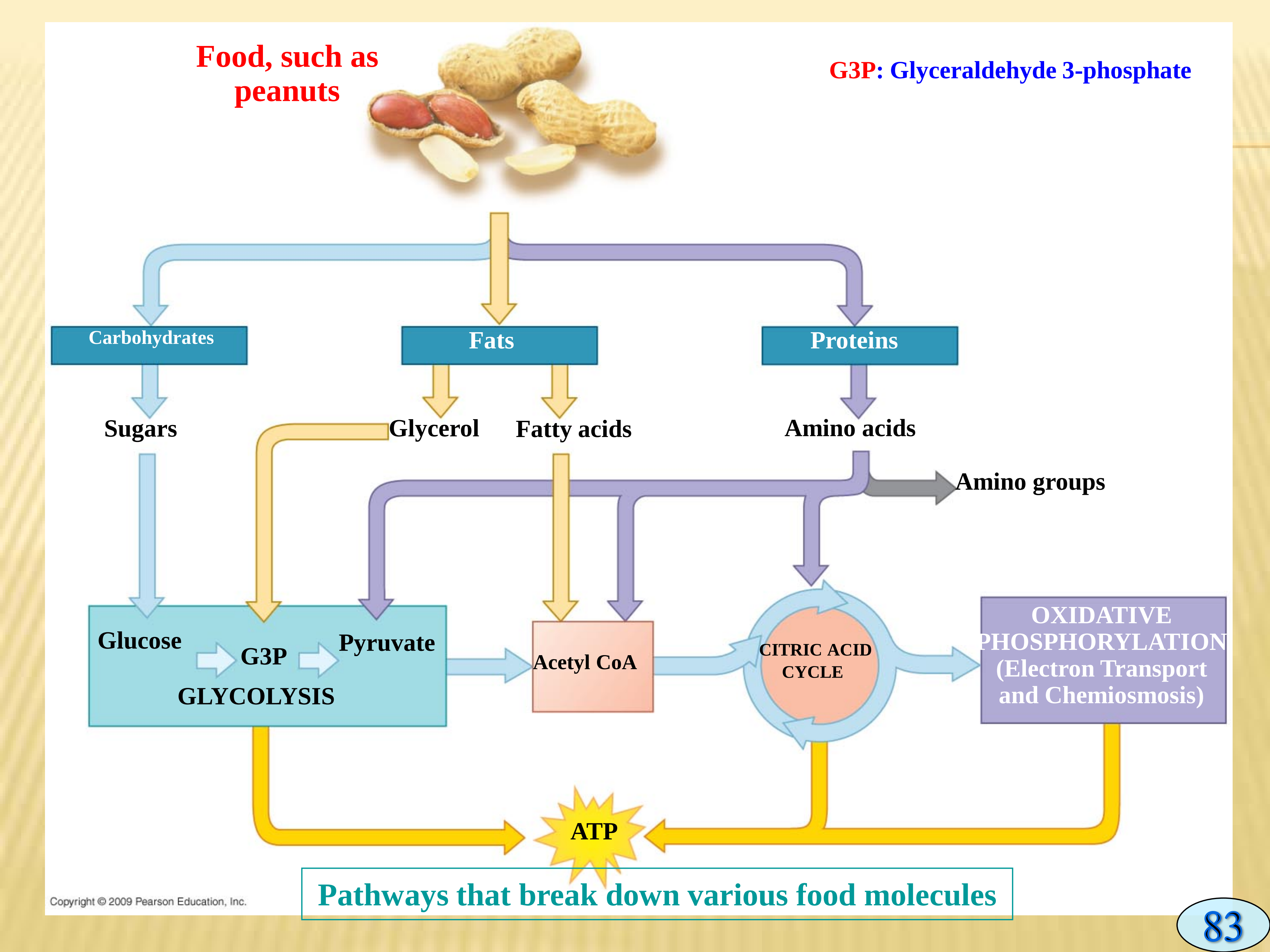
INTERCONNECTIONS BETWEEN MOLECULAR BREAKDOWN AND SYNTHESIS

How do cells extract energy in chemical bonds in organic molecules

- **Although glucose is considered to be the primary source of sugar for respiration and fermentation, there are actually three sources of molecules for generation of ATP**
  - **Carbohydrates (disaccharides)**
  - **Proteins (after conversion to amino acids)**
  - **Fats**

Catabolism of Various Food Molecules

- **Other organic molecules used for fuel.**
- **Fats: glycerols and fatty acids both oxidized as fuel**
- **Proteins: amino acids undergo deamination. Carbon skeletons converted to intermediates of aerobic respiration**



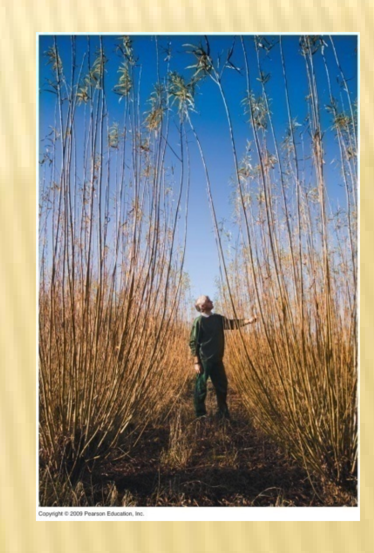
Food, such as peanuts
G3P: Glyceraldehyde 3-phosphate
Carbohydrates
Fats
Proteins
Sugars
Glycerol
Fatty acids
Amino acids
Amino groups
Glucose
G3P
Pyruvate
GLYCOLYSIS
Acetyl CoA
CITRIC ACID CYCLE
OXIDATIVE PHOSPHORYLATION (Electron Transport and Chemiosmosis)
ATP
Pathways that break down various food molecules

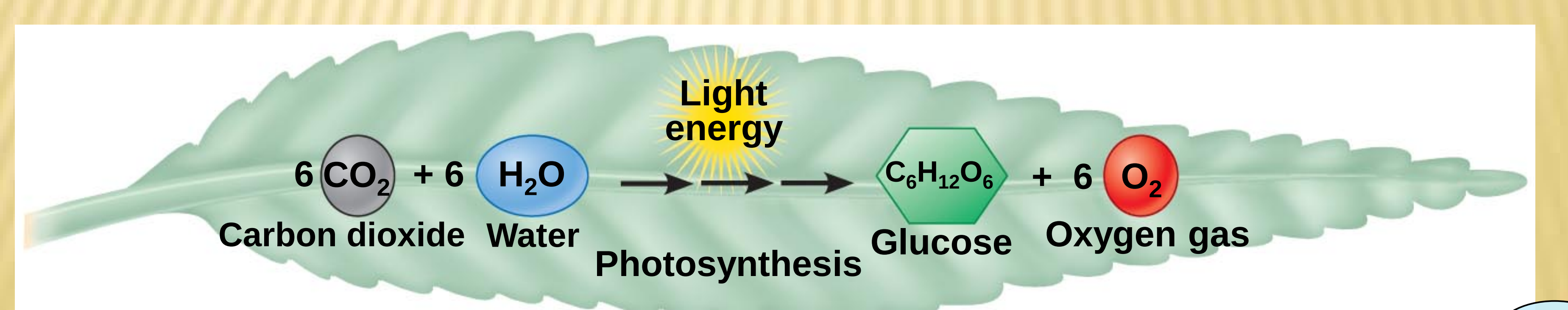
Photosynthesis:

Using Light to Make Food

An overview of photosynthesis

- **Plants use water and atmospheric carbon dioxide to produce a simple sugar and liberate oxygen**
  - **Earth's plants produce 160 billion metric tons of sugar each year through photosynthesis, a process that converts solar energy to chemical energy**
  - **Sugar is food for humans and for animals that we consume**





Photosynthesis

- **Photosynthesis occurs in chloroplasts located in mesophyll cells inside the leaf**
- **Light energy is converted to chemical energy (carbohydrates)**
- **Hydrogens from water reduce carbon**
- **Oxygen from water is oxidized, forming molecular oxygen**

Photosynthesis occurs in chloroplasts in plant cells

- **Chloroplasts are the major sites of photosynthesis in green plants**
  - **Chlorophyll, an important light absorbing pigment in chloroplasts, is responsible for the green color of plants**
  - **Chlorophyll plays a central role in converting solar energy to chemical energy**

Photosynthesis occurs in chloroplasts in plant cells

- **Chloroplasts are concentrated in the cells of the mesophyll, the green tissue in the interior of the leaf**
- **Stomata are tiny pores in the leaf that allow carbon dioxide to enter and oxygen to exit**
- **Veins in the leaf deliver water absorbed by roots**

Autotrophs are the producers of the biosphere

- **Autotrophs** are living things that are able to make their own food without using organic molecules derived from any other living thing
  - Autotrophs that use the energy of light to produce organic molecules are called **photoautotrophs**
  - Most plants, algae and other protists, and some prokaryotes are photoautotrophs



Kelp, a large algae

Autotrophs are the producers of the biosphere

- **The ability to photosynthesize is directly related to the structure of chloroplasts**
  - **Chloroplasts are organelles consisting of photosynthetic pigments, enzymes, and other molecules grouped together in membranes**



Micrograph of Cyanobacteria (photosynthetic bacteria)

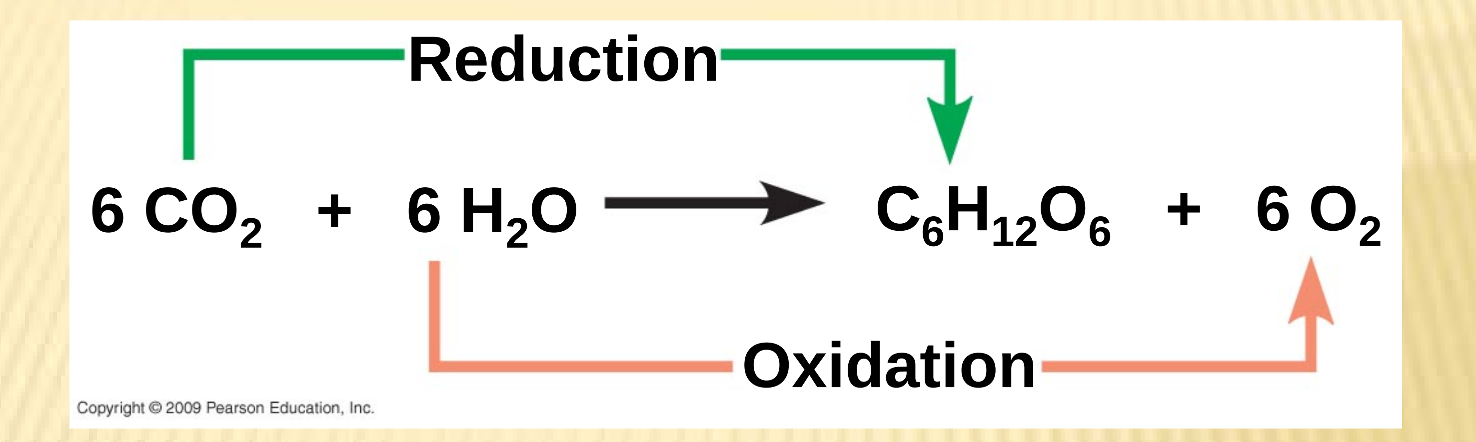
Photosynthesis is a redox process, as is cellular respiration

- **Photosynthesis, like respiration, is a redox (oxidation-reduction) process**
  - **Water molecules are split apart by oxidation, which means that they lose electrons along with hydrogen ions (H^+)**
  - **Then CO_2 is reduced to sugar as electrons and hydrogen ions are added to it**

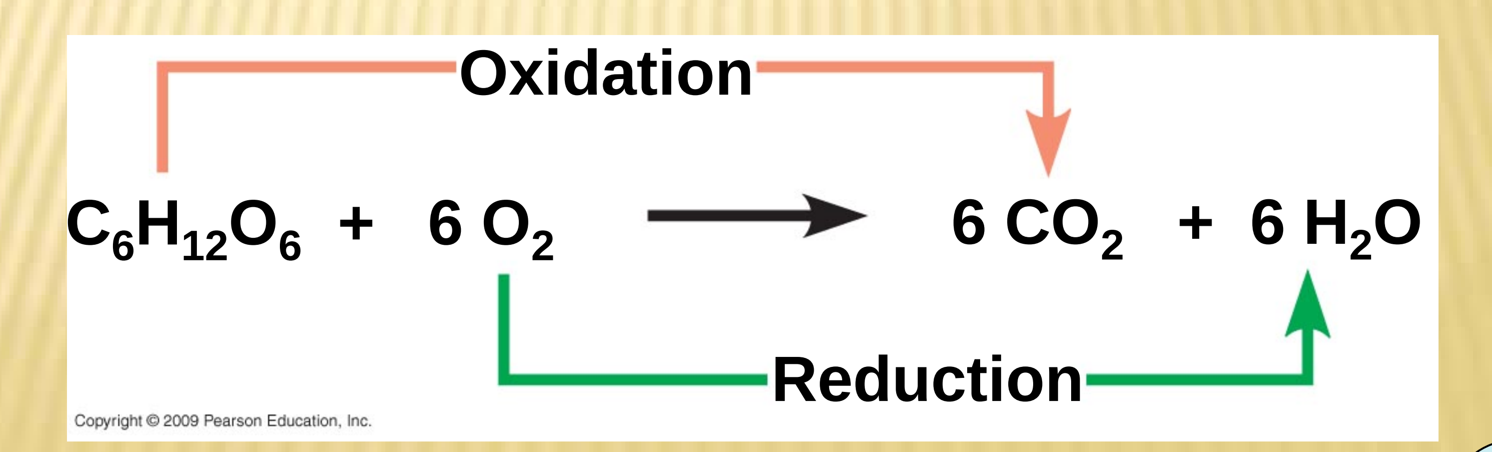
Photosynthesis is a redox process, as is cellular respiration

- **Recall that cellular respiration uses redox reactions to harvest the chemical energy stored in a glucose molecule**
  - **This is accomplished by oxidizing the sugar and reducing O_2 to H_2O**
  - **The electrons lose potential as they travel down an energy hill, the electron transport system**
  - **In contrast, the food-producing redox reactions of photosynthesis reverse the flow and involve an uphill climb**

Photosynthesis (uses light energy)



Cellular respiration (releases chemical energy)



Photosynthesis Reactions

1. Light-dependent reactions

- **light energizes water electrons that generate ATP and NADPH**

2. Carbon fixation reactions

- **use energy of ATP and NADPH to fix CO_2 into carbohydrate**

Overview: The two stages of photosynthesis are linked by ATP and NADPH

- Actually, photosynthesis occurs in two metabolic stages

First stage

- One stage involves the light reactions
- In the light reactions, light energy is converted in the thylakoid membranes to chemical energy and O_2
- Water is split to provide the O_2 as well as electrons

Overview: The two stages of photosynthesis are linked by ATP and NADPH

- H^+ ions reduce $NADP^+$ to NADPH, which is an electron carrier similar to NADH
  – NADPH is temporarily stored and then shuttled into the Calvin cycle where it is used to make sugar
  – Finally, the light reactions generate ATP

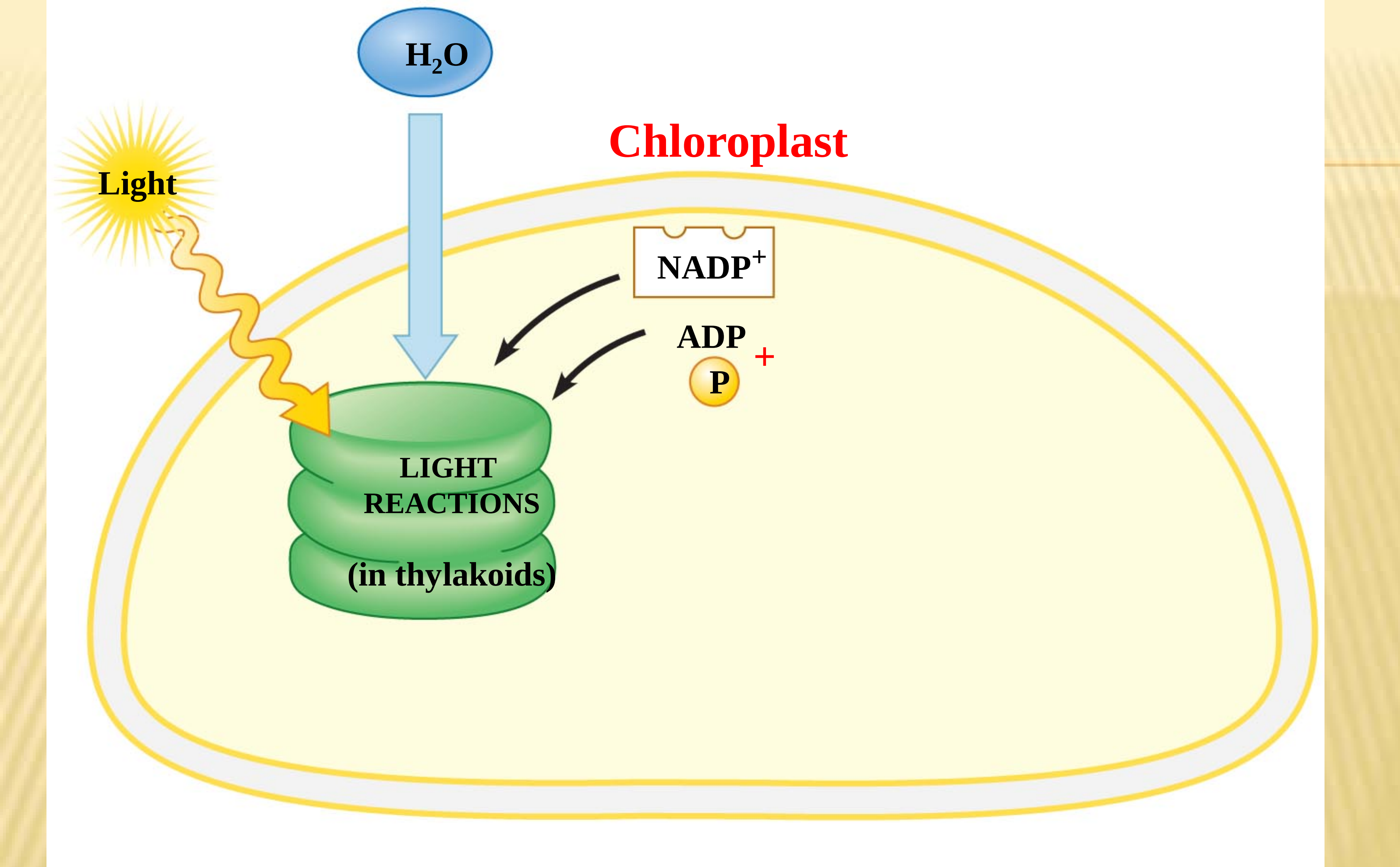
Overview: The two stages of photosynthesis are linked by ATP and NADPH

Second stage

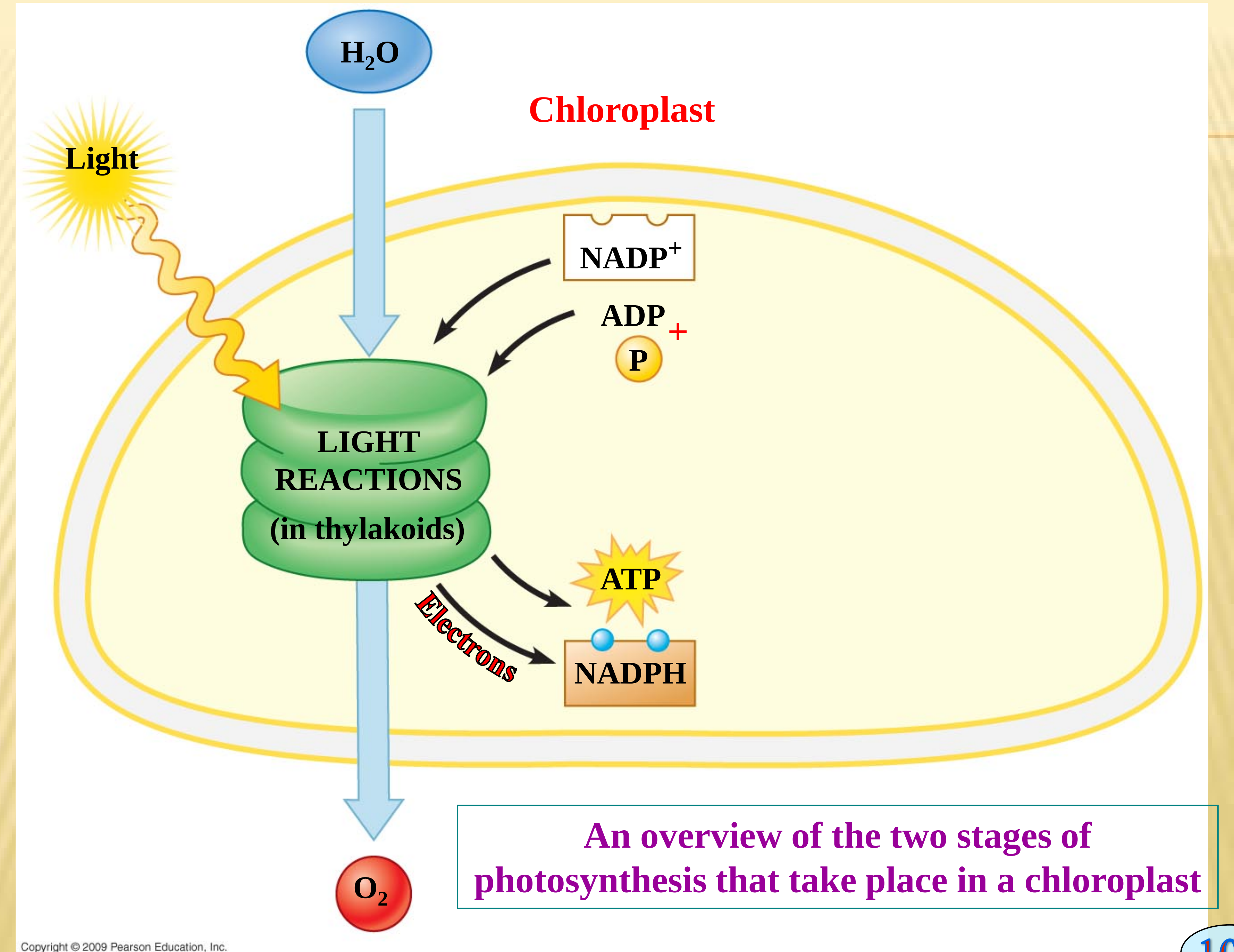
- The second stage is the Calvin cycle, which occurs in the stroma of the chloroplast
  - It is a cyclic series of reactions that builds sugar molecules from CO_2 and the products of the light reactions
  - During the Calvin cycle, CO_2 is incorporated into organic compounds, a process called carbon fixation

Overview: The two stages of photosynthesis are linked by ATP and NADPH

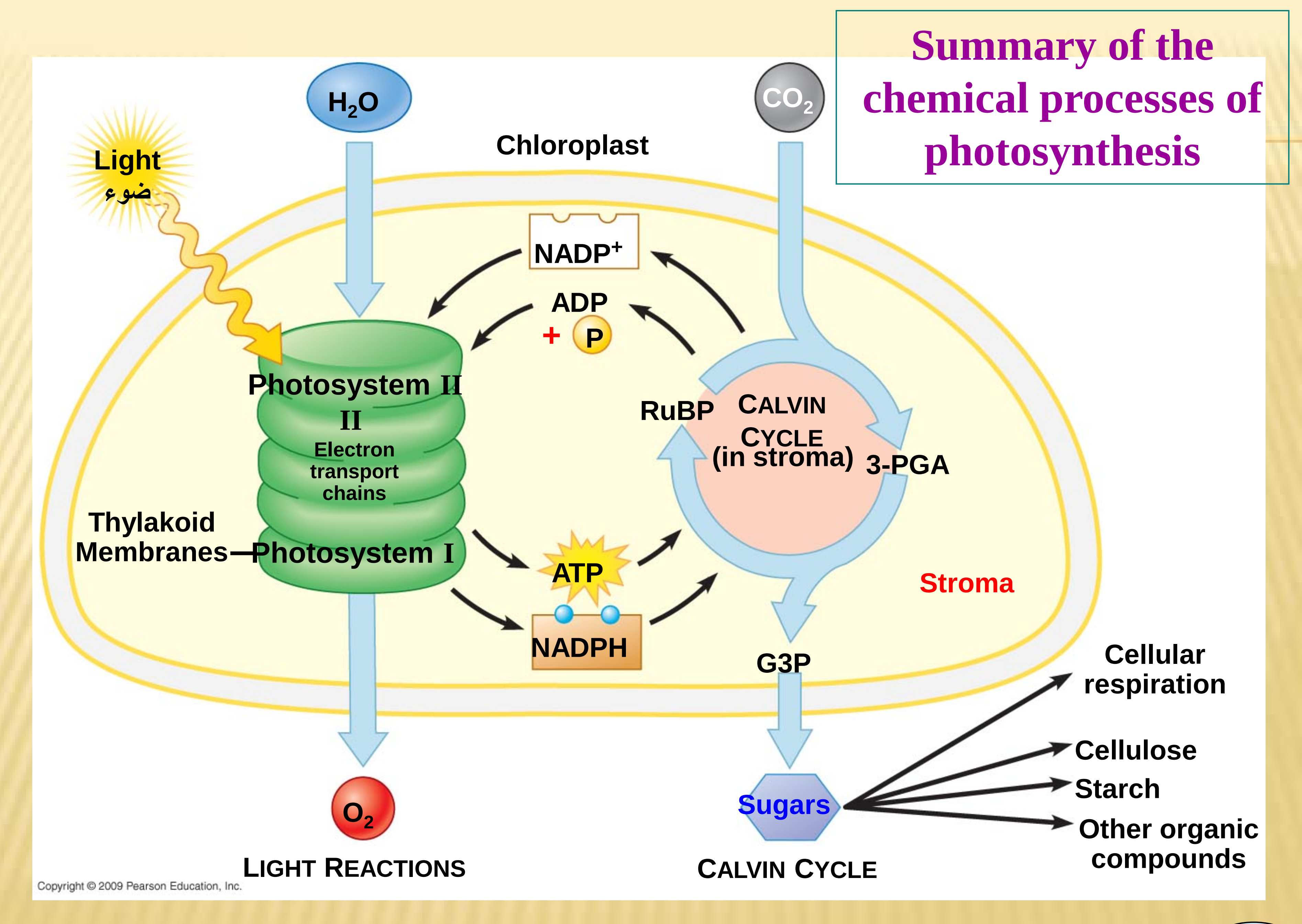
- NADPH produced by the light reactions provides the electrons for reducing carbon in the Calvin cycle
  - ATP from the light reactions provides chemical energy for the Calvin cycle
  - The Calvin cycle is often called the dark (or light-independent) reactions



An overview of the two stages of photosynthesis that take place in a chloroplast



H_2O
Chloroplast
Light
NADP+
ADP
+
P
LIGHT REACTIONS
(in thylakoids)
ATP
Electrons
NADPH
O_2
An overview of the two stages of photosynthesis that take place in a chloroplast



Summary of the chemical processes of photosynthesis
Light
ضوء
H_2O
Chloroplast
CO_2
$NADP^+$
ADP
+ P
Photosystem II
II
Electron transport chains
Thylakoid Membranes
Photosystem I
ATP
NADPH
RuBP
CALVIN CYCLE
(in stroma)
3-PGA
Stroma
G3P
Cellular respiration
Cellulose
Starch
Other organic compounds
Sugars
O_2
LIGHT REACTIONS
CALVIN CYCLE

Review: Photosynthesis uses light energy, CO_2, and H_2O to make food molecules

- The chloroplast, which integrates the two stages of photosynthesis, makes sugar from CO_2
  - All but a few microscopic organisms depend on the food-making machinery of photosynthesis
  - Plants make more food than they actually need and stockpile it as starch in roots, tubers, and fruits

PHOTOSYNTHESIS,
SOLAR RADIATION,
AND EARTH'S ATMOSPHERE

CONNECTION: Photosynthesis moderates global warming

- The greenhouse effect results from solar energy warming our planet
  - Gases in the atmosphere (often called greenhouse gases), including CO_2, reflect heat back to Earth, keeping the planet warm and supporting life
  - However, as we increase the level of greenhouse gases, Earth's temperature rises above normal, initiating problems

7.13 CONNECTION: Photosynthesis moderates global warming

- **Increasing concentrations of greenhouse gases lead to global warming, a slow but steady rise in Earth's surface temperature**
  - **The extraordinary rise in CO_2 is mostly due to the combustion of carbon-based fossil fuels**
  - **The consequences of continued rise will cause melting of polar ice, changing weather patterns, and spread of tropical disease**

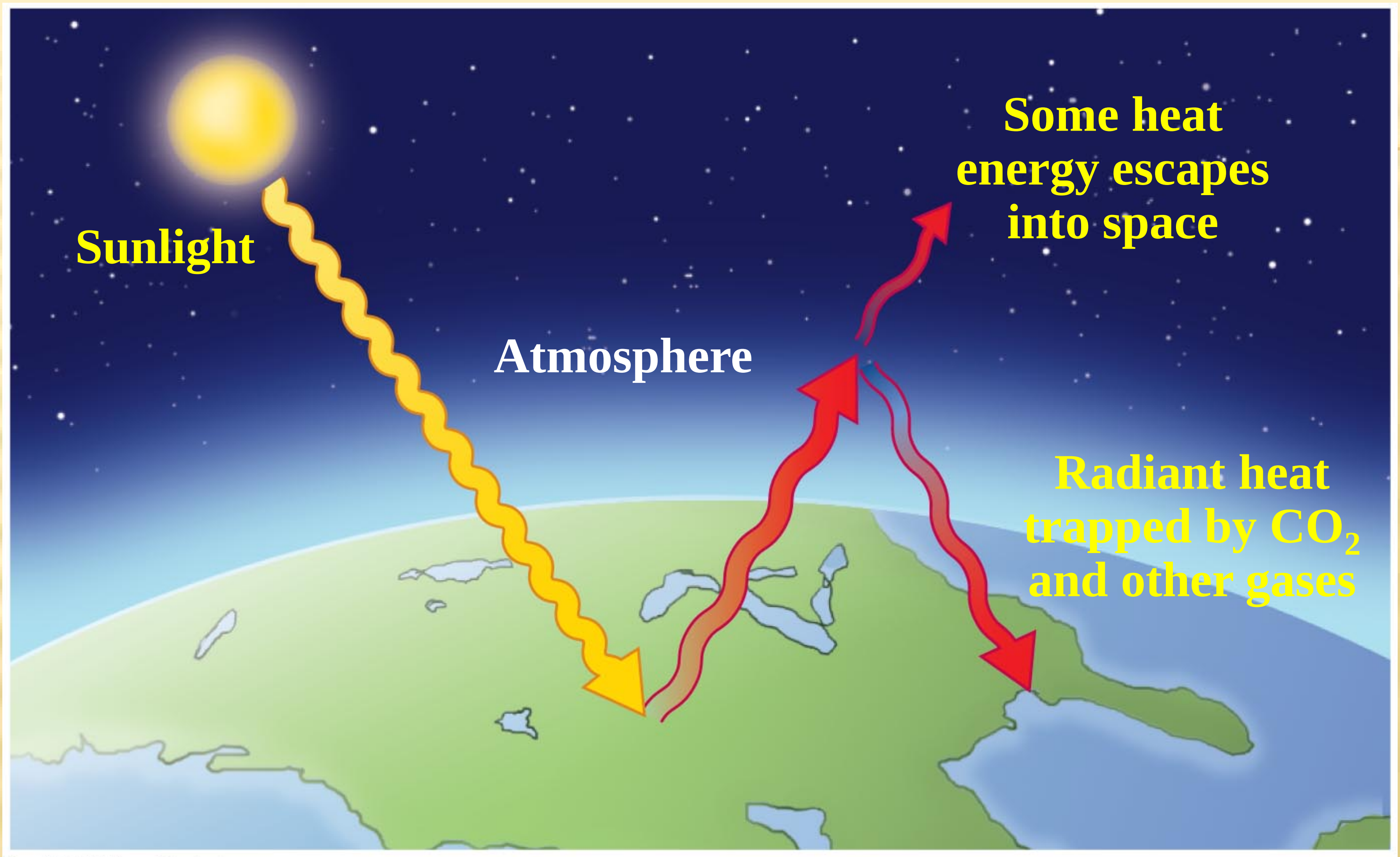
7.13 CONNECTION: Photosynthesis moderates global warming

- Perhaps photosynthesis can mitigate the increase in atmospheric CO_2

  – However, there is increasing widespread deforestation, which aggravates the global warming problem



Plants growing in a greenhouse



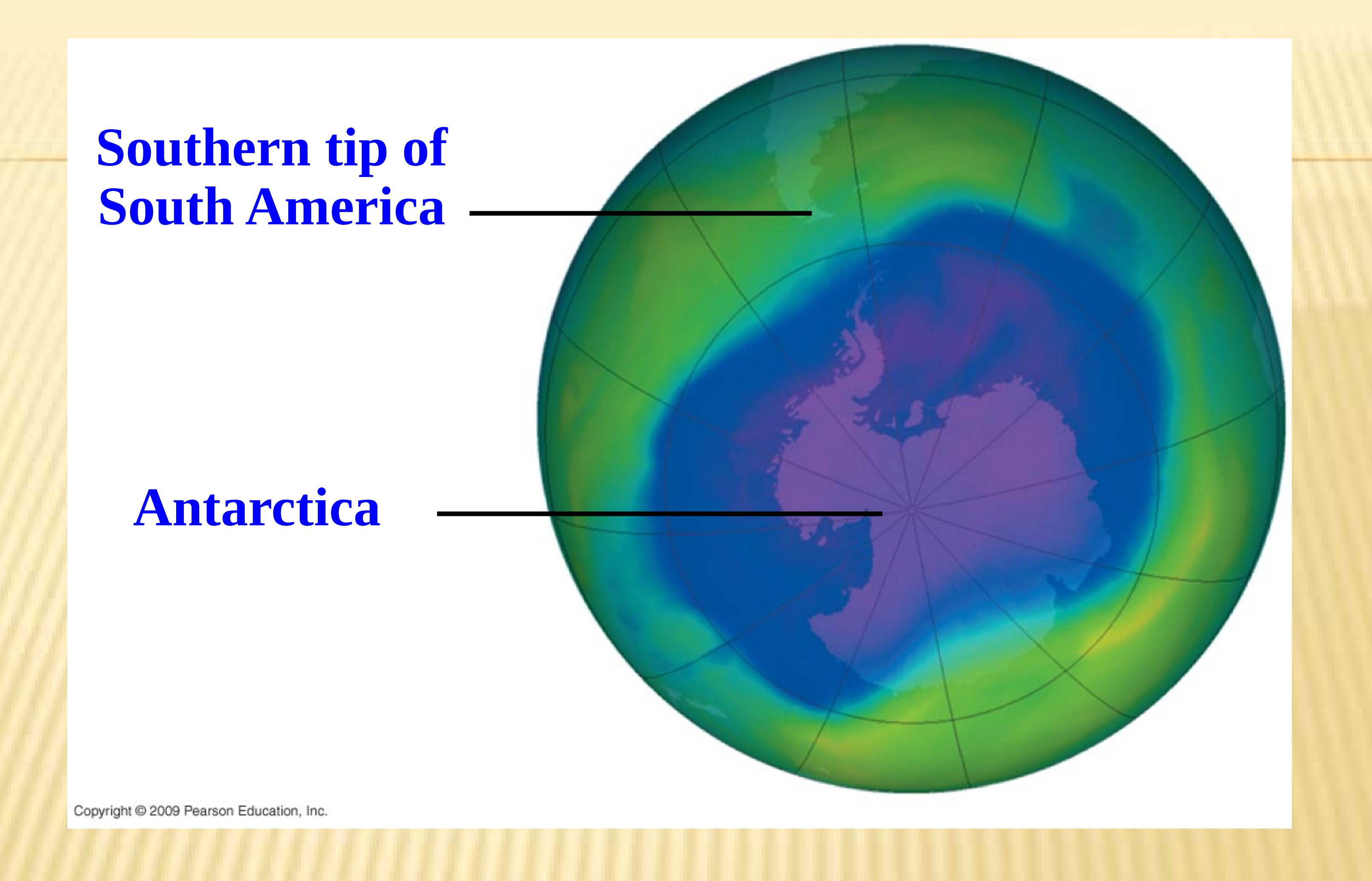
CO_2 in the atmosphere and global warming

7.14 TALKING ABOUT SCIENCE: Mario Molina talks about Earth's protective ozone layer

- **Dr. Mario Molina at the University of California, San Diego, received a Nobel Prize for research on damage to the ozone layer**
  - **Ozone provides a protective layer (the ozone layer) in our atmosphere to filter out powerful ultraviolet radiation**
  - **Dr. Molina showed that industrial chemicals called chlorofluorocarbons (CFCs), deplete the ozone layer**



Mario Molina



The ozone hole in the Southern Hemisphere, spring 2006

CHAPTER 7

BIOLOGICAL DIVERSITY

Means

BIODIVERSITY

How are Organisms Named and Classified?

- **Organisms are placed into categories on the basis of their evolutionary relationships.**
- **These categories form a nested hierarchy in which each level includes all the ones before it.**
- **There are eight major categories:**
  - **Domain, kingdom, phylum, class, order, family, genus, species.**

How are Organisms Named and Classified?

Table 16-1 Classification of Selected Organisms, Reflecting Their Degree of Relatedness*

	Human	Chimpanzee	Wolf	Fruit Fly	Sequoia Tree	Sunflower
Domain	**Eukarya**	**Eukarya**	**Eukarya**	**Eukarya**	**Eukarya**	**Eukarya**
Kingdom	**Animalia**	**Animalia**	**Animalia**	**Animalia**	**Plantae**	**Plantae**
Phylum	**Chordata**	**Chordata**	**Chordata**	Arthropoda	Coniferophyta	Anthophyta
Class	**Mammalia**	**Mammalia**	**Mammalia**	Insecta	Coniferosida	Dicotyledoneae
Order	**Primates**	**Primates**	Carnivora	Diptera	Coniferales	Asterales
Family	Hominidae	Pongidae	Canidae	Drosophilidae	Taxodiaceae	Asteraceae
Genus	*Homo*	*Pan*	*Canis*	*Drosophila*	*Sequoiadendron*	*Helianthus*
Species	*sapiens*	*troglodytes*	*lupus*	*melanogaster*	*giganteum*	*annuus*

**Boldface categories are those that are shared by more than one of the organisms classified. Genus and species names are always italicized or underlined.*

How are Organisms Named and Classified?

- **The scientific name of an organism is a two-part name formed from the genus and species categories.**
- **Each genus includes a group of closely related species, and within each species are individuals that can interbreed.**

How are Organisms Named and Classified?

- **For example: The genus *Sialia* (bluebirds) includes similar birds (group of closely related species) that do not interbreed:**

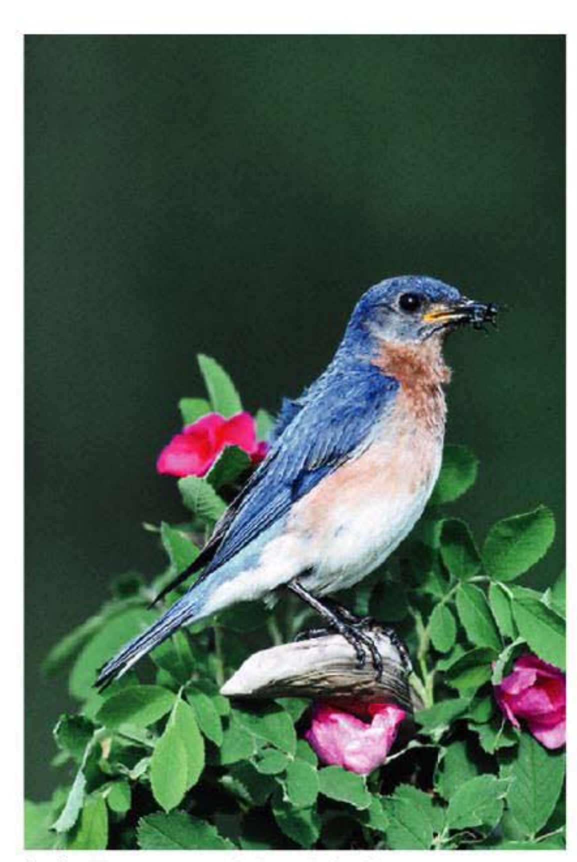
  The eastern bluebird (*Sialia sialis*),

  The western bluebird (*Sialia mexicana*),

  The mountain bluebird (*Sialia currucoides*).

How are Organisms Named and Classified?

- Three species of bluebird


(a) Eastern bluebird


(b) Western bluebird


(c) Mountain bluebird

How are Organisms Named and Classified?

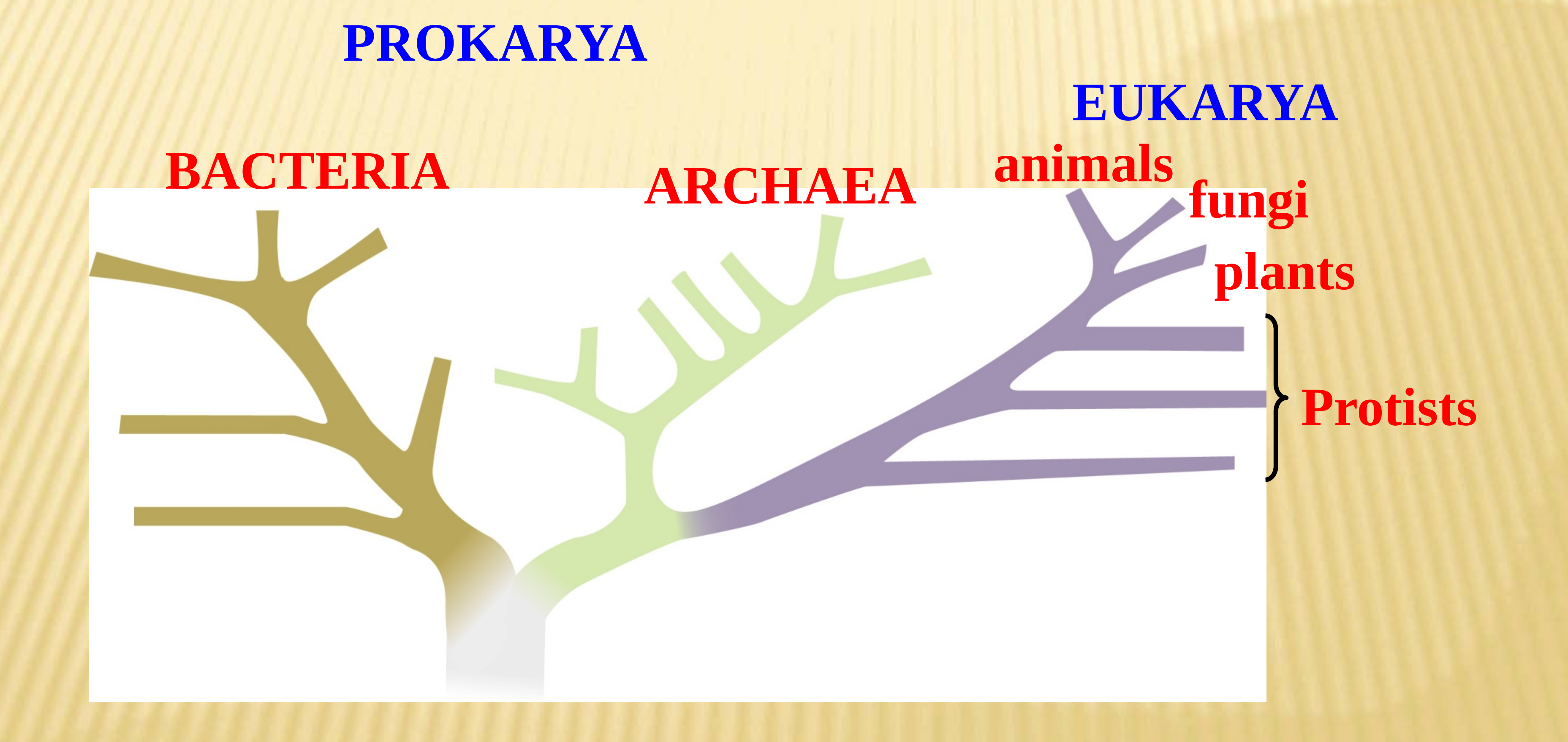
- **Each two-part scientific name is unique; referring to an organism by its scientific name rules:**
  - **Scientific names are <u>underlined</u> or *italicized.***
  - **The first letter of the genus name is always capitalized, and the first letter of the species name is always lowercase.**
  - **The species name is never used alone but is always paired with its genus name.**

How are Organisms Named and Classified?

- **Biologists identify features that reveal evolutionary relationships.**
  - **Scientists must distinguish informative similarities caused by common ancestry from uninformative similarities that result from convergent evolution.**
  - **In the search for informative similarities, biologists look at many kinds of characteristics.**
    - **Anatomical similarities play a key role in classification.**
    - **Molecular similarities are also useful in classification.**

What Are The Domains of Life?

- The three domains: Bacteria, Archaea, and Eukarya.



What are The Domains of Life?

- Kingdom-level classification remains unsettled.
- Biologists recognized:
  - 15 kingdoms among the Bacteria.
  - 3 kingdoms in the Archaea
  - 4 kingdoms among the Eukarya, these are

• Animals	مملكة الحيوانات •
• Plants	مملكة النباتات •
• Fungi	مملكة الفطريات •
• Protists	مملكة الأوليات •

Bacteria and Archaea

- **Earth's first organisms were prokaryotes**
  - **In terms of abundance, prokaryotes are Earth's predominant form of life.**
  - **Prokaryotes include Bacteria and Archaea**
  - **They are single-celled microbes that lacked organelles such as a nucleus, chloroplasts and mitochondria.**

Bacteria and Archaea

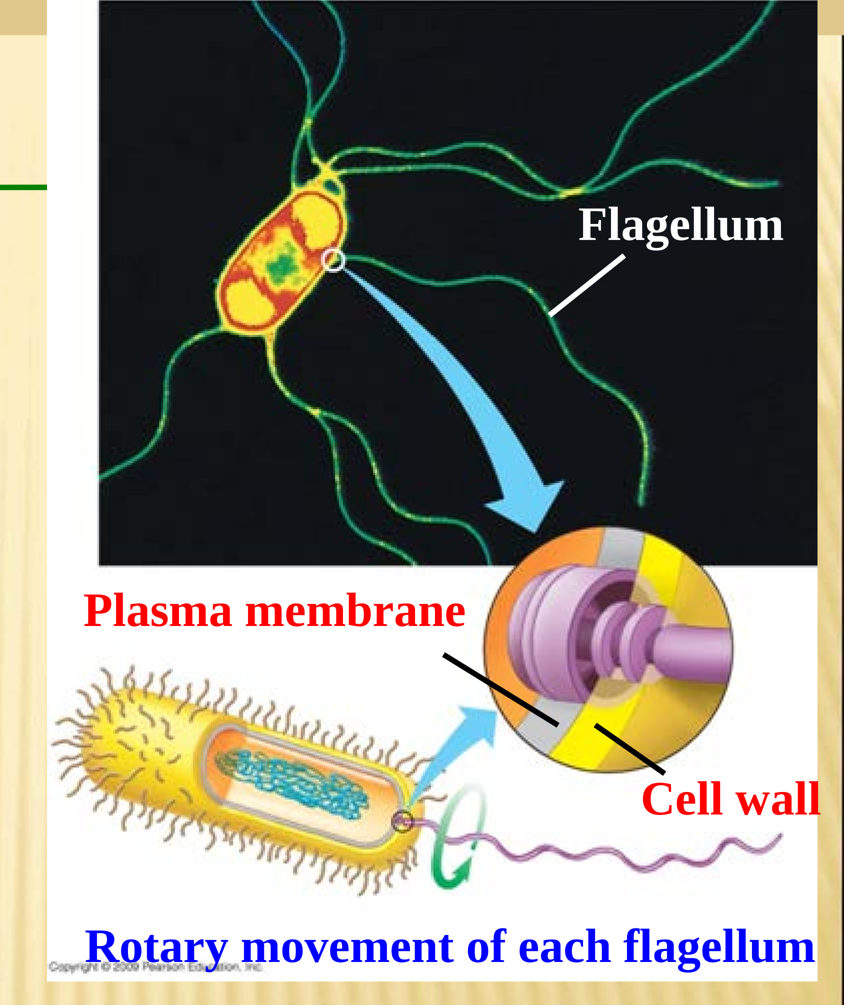
- **Bacteria and Archaea are fundamentally different.**
  - **Bacterial cells contain molecules of the polymer peptidoglycan, which strengthens the cell wall.**
  - **They also differ in the structure and composition of the plasma membrane, ribosomes, and RNA polymerases, as well as in the processes of transcription and translation.**

Bacteria and Archaea

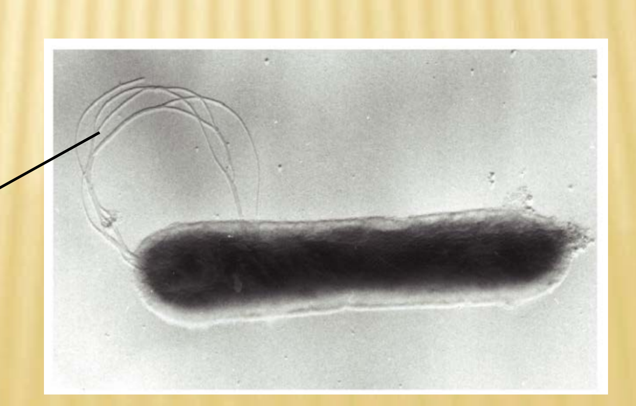
- The biochemical differences between archaea and bacteria make distinguishing the two domains easy.
- Classification within each domain is difficult.
- Prokaryotes have been classified on the basis of shape, means of locomotion, pigments, nutrient requirements, the appearance of colonies and staining properties.
- More recently, the comparisons of DNA and RNA nucleotide sequences have been used in prokaryotic classification.

Bacteria and Archaea

- **Some prokaryotes are mobile; some may have flagella.**
  - **Flagella can rotate rapidly and propel the organism through the environment.**



EM micrograph showing flagella



Bacteria and Archaea

- Protective endospores allow some bacteria to withstand adverse conditions.
  - The endospore forms within the bacterium, and contains genetic material and a few enzymes encased in a thick protective coat.
  - Metabolic activity ceases until the spore encounters favorable conditions, which may take an extremely long period of time.



Bacteria and Archaea

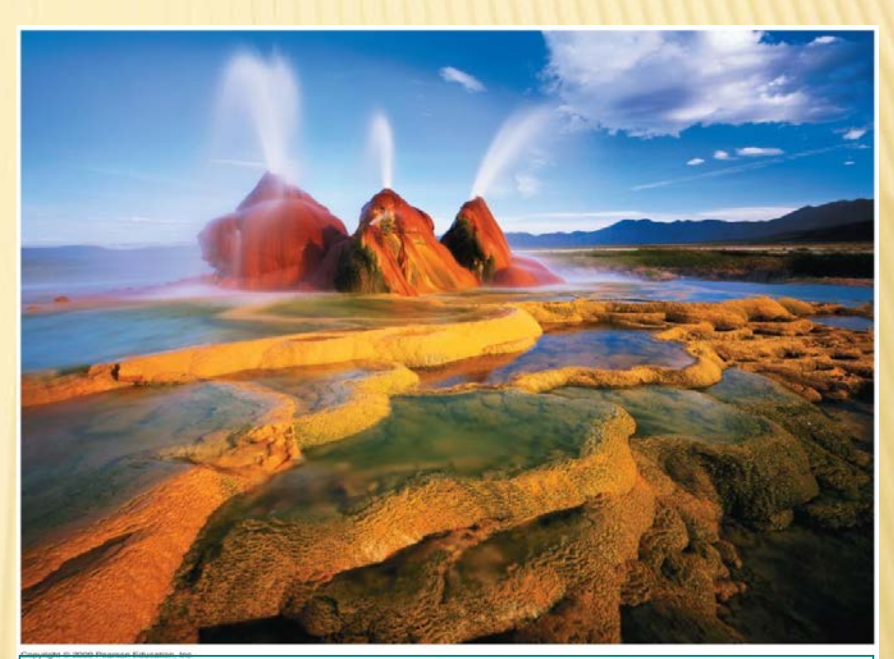
- **Prokaryotes are specialized for specific habitats.**
  - **Prokaryotes occupy virtually every habitat, including those where extreme conditions keep out other forms of life.**
  - **Many archaea can live in hot springs at temperatures up to 110°C; they can live at extreme pressures beneath the Earth's surface, and at very cold temperatures of the Antarctic.**
  - **They can live in the Dead Sea, with salt concentrations seven times those of the ocean.**

1-“Salt-loving” archaea
extreme halophiles

2-“Heat-loving” archaea
extreme thermophiles



Archaea growing in seawater-evaporating ponds
The purplish color of the ponds (top of photo) is due to a unique photosynthesizer archaean (*Halobacterium halobium)* withy purple molecule that traps solar energy



Orange and yellow colonies of extreme “heat-loving” archaea, thermophiles, growing in a Nevada geyser

Bacteria and Archaea

- **Prokaryotes exhibit diverse metabolisms.**
  - **Many prokaryotes are anaerobes; their metabolisms do not require oxygen.**
  - **Others are opportunistic, using anaerobic respiration when oxygen is absent and switching to aerobic respiration when oxygen is available.**

Bacteria and Archaea

- **Prokaryotes feed on many things, including sugars, proteins and fats, but also petroleum, methane, benzene and toluene; some can use hydrogen, sulfur, ammonia, iron, and nitrate.**

- **Some prokaryotes possess chlorophyll and are photosynthetic.**

Bacteria and Archaea

- **Most prokaryotes reproduce asexually by binary fission.**
  - **They produce identical copies of the original cell.**
  - **They reproduce rapidly and can evolve quickly to adapt to changing conditions.**

Bacteria and Archaea

- **Prokaryotes affect humans and other organisms.**
  - **Prokaryotes play important roles in animal nutrition.**
  - **Many animals that eat plants cannot digest the cellulose in plants themselves and rely on symbiotic bacteria in their digestive tracts, which are able to digest cellulose, to liberate nutrients from this food source.**

Bacteria and Archaea

- **Many foods that humans eat are produced by the actions of bacteria, including cheese, yogurt and sauerkraut.**

- **Some bacteria in human intestines feed on undigested food and synthesize nutrients, such as vitamin K and vitamin B_{12}, which the human body absorbs.**

Bacteria and Archaea

- **Prokaryotes are nature's recyclers.**
  - **Prokaryotes consume the organic molecules in the dead bodies of plants and animals, decomposing their wastes and recycling them to the environment.**
  - **Prokaryotes can clean up pollution.**

Bacteria and Archaea

- Nearly anything that human beings can synthesize can be broken down by some prokaryote, including detergents, toxic pesticides and harmful industrial chemicals.

- Even oil can be broken down by prokaryotes.

- The breakdown of pollutants by bacteria is called **bioremediation**.

Bacteria and Archaea

- **Some anaerobic bacteria produce dangerous poisons.**
  - **Some bacteria produce toxins that attack the nervous system.**
  - ***Clostridium tetani* causes tetanus (neck and muscle spasm).**
  - ***C. botulinum* causes botulism (lethal food poisoning).**

Bacteria and Archaea

- Pathogenic (disease-causing) bacteria synthesize toxic substances that cause diseases in humans.

  - Bubonic plague ("Black death") killed 100 million people during the fourteenth century.

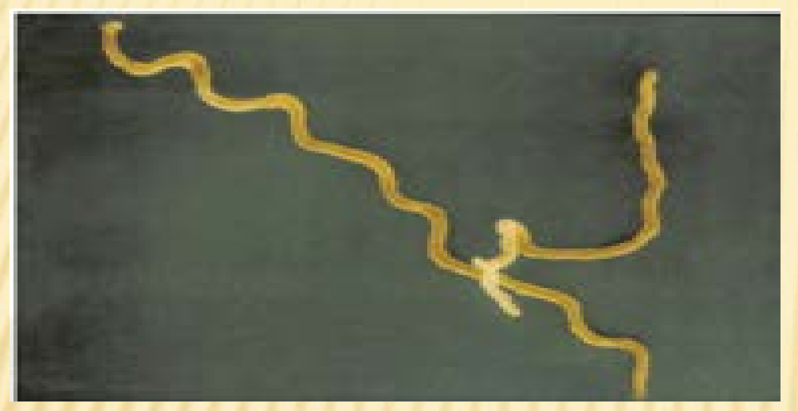
  - Tuberculosis, gonorrhea, syphilis and cholera are bacterial diseases long associated with humans.

  - Lyme disease, a bacterial disease transmitted by ticks to humans.

Bacteria and Archaea

Spirochete that causes Lyme disease

Tick that carries Lyme disease bacterium







Bacteria and Archaea

- **Common bacterial species can be harmful.**
  - **Streptococcus causes strep throat.**
  - **Another causes pneumonia, which clogs the lungs with fluid.**
  - **A common bacterium of the human digestive tract, *E. coli* (*Escherichia coli*), normally is benign but can transform into a pathogenic form that can be transmitted from human to human.**

- The *bacterium* that causes anthrax can be used as biological weapons
- Weaponizing anthrax involves manufacturing endospores that disperse easily in air, where they are inhaled and germinate in lungs

Cleaning up after an anthrax attack in October 2001



Domain Eukarya

Domain Eukarya is divided into four kingdoms:

- **Protists (everything that doesn’t fit into the other three kingdoms)**
- **Plants**
- **Fungi**
- **Animals**

Protists

- **The protists are eukaryotes that are not a plant, an animal, or a fungus.**
  - **Most protists are small and single-celled.**
  - **They are incredibly diverse in their modes of reproduction and in their structural and physiological innovations.**
  - **Some of the larger protists are colonies of single-celled individuals, while others are multicellular organisms.**

Protists

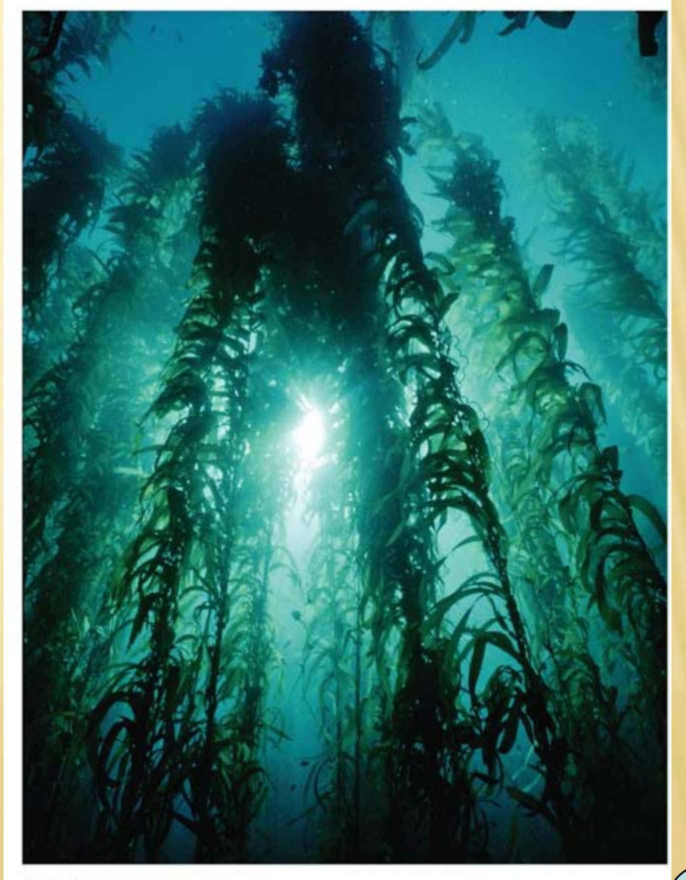
- **Protists have both positive and negative effects upon humans and other organisms.**
  - **The primary positive impact comes from the ecological roles of photosynthetic marine protists.**
  - **On the negative side are the many human diseases caused by parasitic protists.**

Protists

- **Brown algae dominate in cool coastal waters and form multicellular aggregations known as brown algae seaweeds.**



(a) *Fucus*



(b) Kelp forest

Protists

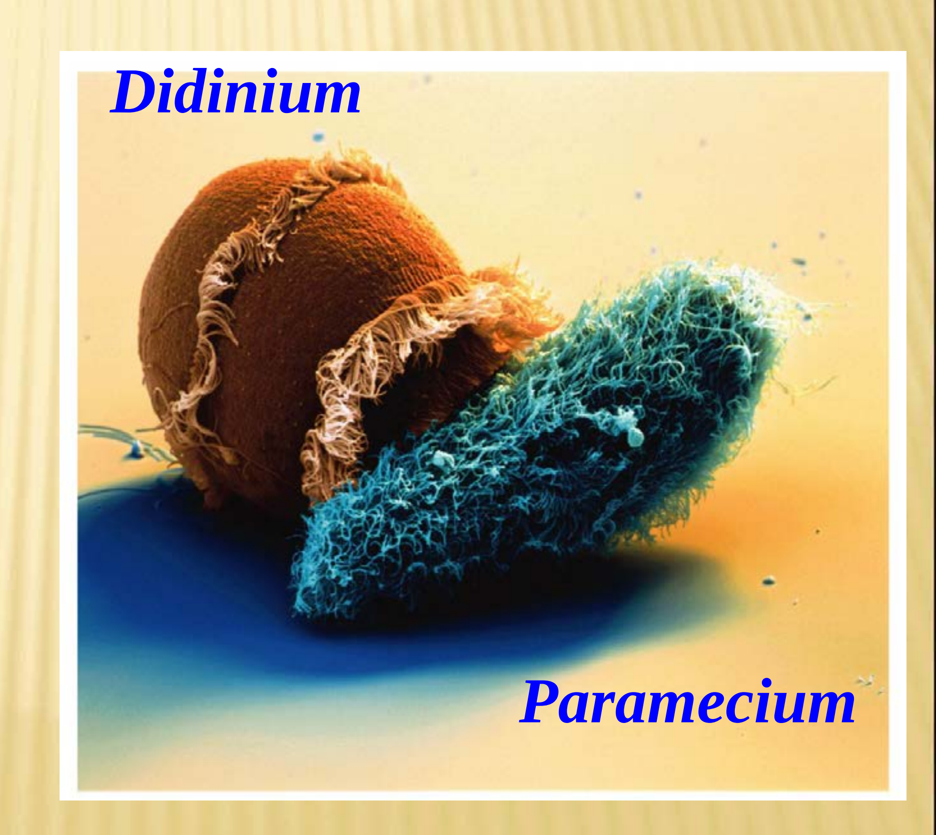
- **Alveolates** include parasites, predators, and phytoplankton.
  - **Dinoflagellates** are important components of the phytoplankton and are food sources for larger organisms.
  - Most dinoflagellates are photosynthetic and move with the use of their two whiplike flagella.



Dinoflagellates

Protists

- **Ciliates are the most complex of the alveolates.**
  - **They possess hair-like outgrowths of the plasma membrane that are used for locomotion.**
  - **Two examples are *Paramecium* and the predator, *Didinium*.**



Protists

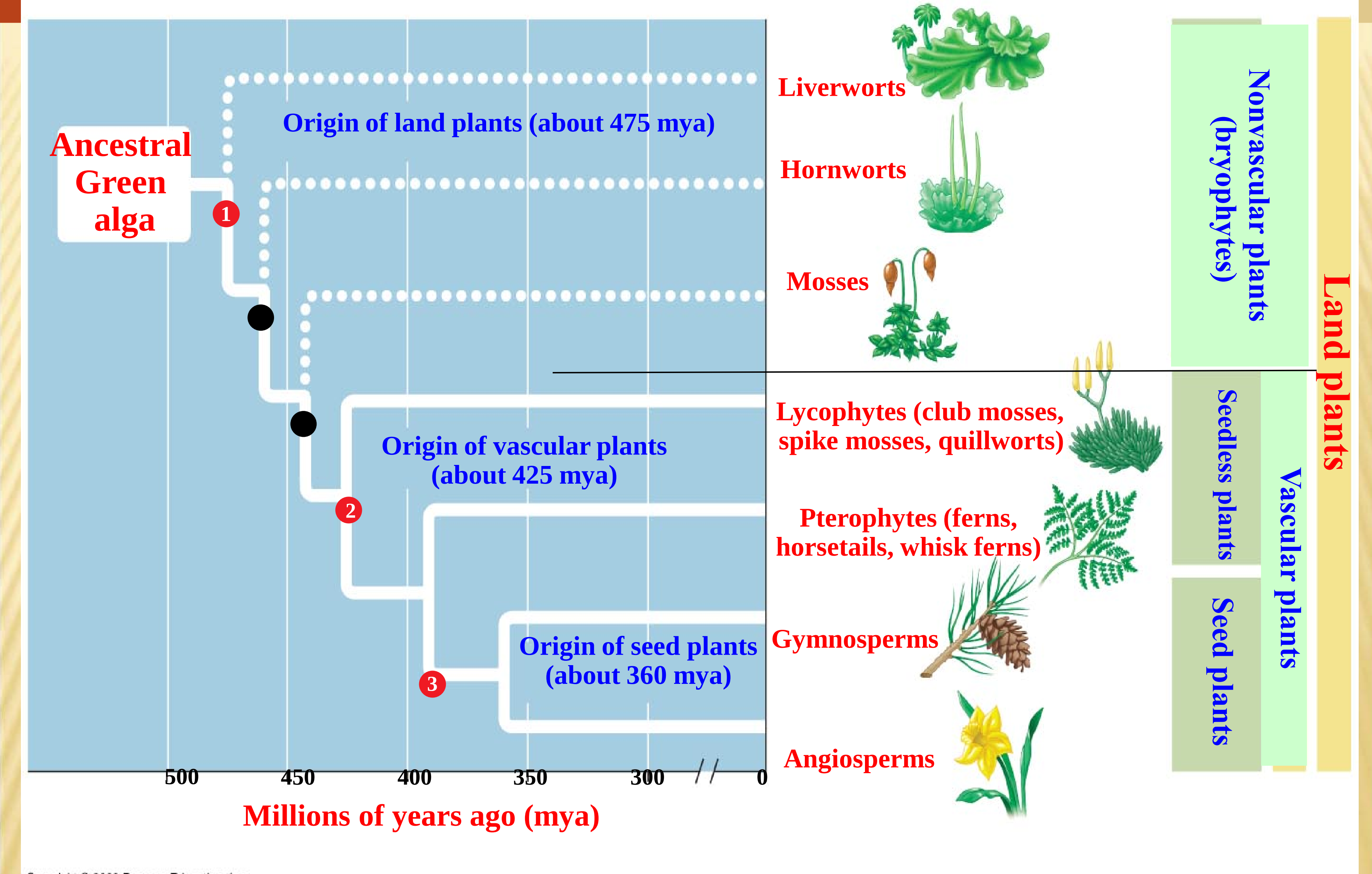
- **Green algae live mostly in ponds and lakes.**
  - **Some forms are small and live in freshwater, such as *Spirogyra*, which forms thin filaments from long chains of cells.**
  - **A marine example, *Ulva*, or sea lettuce, has leaves the size of lettuce leaves.**
  - **Green algae is believed to be the ancestral to the earliest plants.**



Green algae

Plants

- **Properties that distinguish plants from other organisms:**
  - **Plants have chlorophyll for photosynthesis.**
  - **Plant reproduction features alternation of generations.**
  - **Plants have dependent embryos.**
  - **Plants have roots or root-like structures that anchor it and absorb water and nutrient from the soil.**
  - **Plants have a waxy cuticle that covers the surface of leaves and stems, limiting water loss.**



Some highlights of plant evolution
(Dotted lines indicate uncertain evolutionary relationships)

Plants

- Two major groups of land plants arose from ancient algal ancestors: the nonvascular plants and the vascular plants.
- Nonvascular plants lack conducting structures, true roots, leaves, or stems.
  - They have rhizoids that anchor the plant and bring water and nutrients into the plant body.
  - Body size is limited due to the lack of conducting tissues, and slow diffusion must distribute water and nutrients throughout the plant body.
  - Nonvascular plants include hornworts, liverworts, and mosses.

Plants

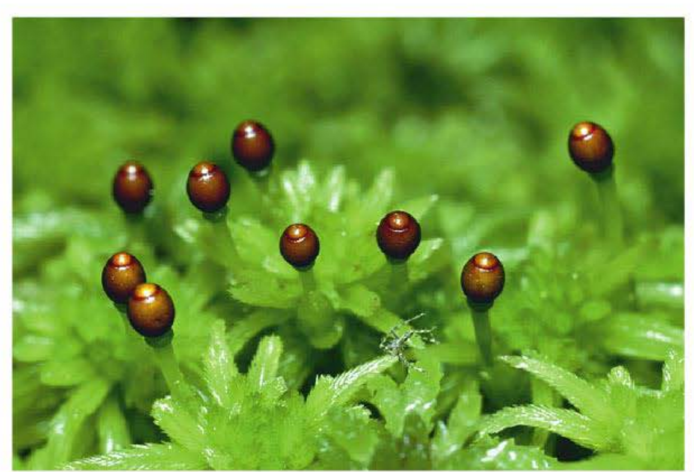
- **Nonvascular plants**



(a) Hornwort



(b) Liverwort



(c) Moss

Plants

- **The reproductive structures of nonvascular plants are protected.**
  - **An adaptation to terrestrial life is their enclosed reproductive structures, which prevent the gametes from drying out.**
  - **There are two types of structures, one in which eggs develop and one in which sperm are formed.**
  - **In all vascular plants, the sperm must swim to the egg through a film of water.**

Plants

- **Vascular plants have conducting vessels that also provide support.**
  - **The conducting cells of vascular plants are called vessels, which contain lignin that serve support and conducting functions.**
  - **Vascular plants can grow tall because of vessels that provide support to these structures as well as conducting of water and nutrients between the roots to the leaves.**
  - **There are two groups of vascular plants: the seedless vascular plants and the seed plants.**

Plants

- **Seedless vascular plants include the club mosses, horsetails, and ferns.**
  - **They require swimming sperm and water for reproduction.**
  - **They propagate by spores, not seeds.**
  - **Their ancestors were larger than present-day forms, and they dominated the landscape hundreds of millions of years ago.**

Plants

- **Seedless vascular plants**



(a) Club moss



(b) Horsetail



(c) Fern

Plants

- **Seed plants are grouped into two general types:**

1- Gymnosperms, which lack flowers

2- Angiosperms, the flowering plants.

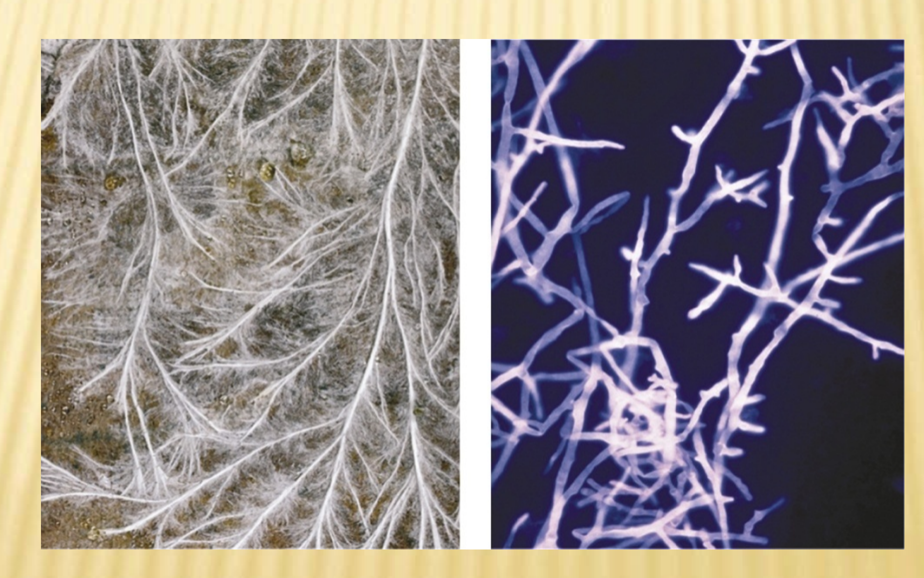
- **Gymnosperms evolved earlier than the flowering plants.**

Fungi

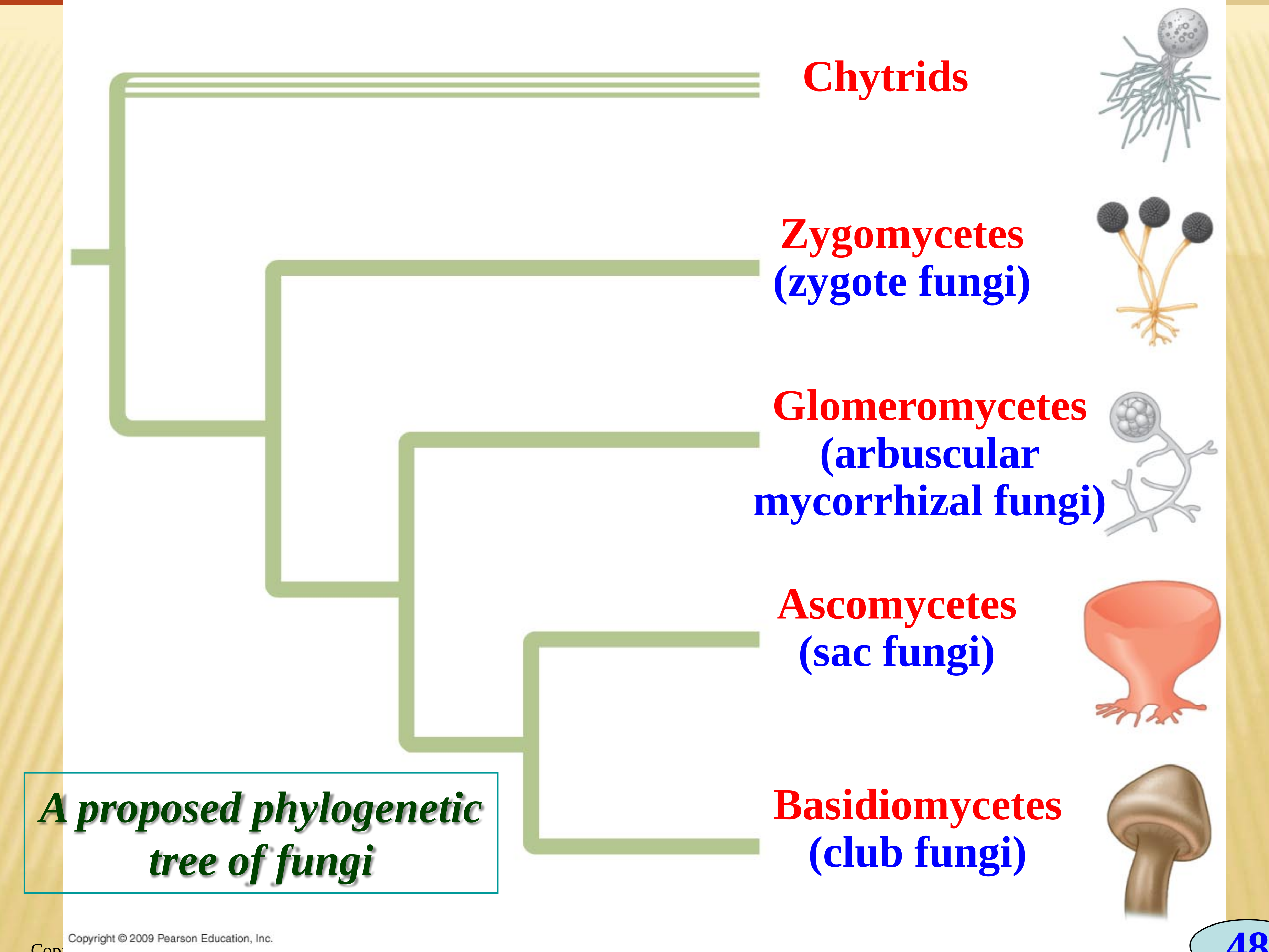
- **Fungi have distinctive adaptations.**
  - **A typical fungus is a mushroom, which is actually the reproductive part of a more extensive organism.**
  - **Fungi feed off dead material by secreting digestive fluids that break down their food outside of their bodies.**

Fungi

- **The body of a fungus is called a mycelium and is one-cell thick.**
- **The mycelium is made up of extensive numbers of filaments called hyphae, which grow across a food source.**



(a) Mycelium **(b) Hyphae**



Chytrids
Zygomycetes
(zygote fungi)
Glomeromycetes
(arbuscular
mycorrhizal fungi)
Ascomycetes
(sac fungi)
Basidiomycetes
(club fungi)
A proposed phylogenetic
tree of fungi
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Fungi

- **Fungi affect humans and other organisms.**
  - **Fungi play a major role in the destruction of dead plant tissue by being able to digest both lignin and cellulose, the molecules that make up wood.**
  - **Fungi are saprophytes (feeding on dead organisms) and consume the dead of all kingdoms.**
  - **The activities of fungi and bacteria return nutrients and minerals to the environment.**
  - **Antibiotics (such as penicillin, oleandomycin, and cephalosporin) are made from fungi to combat bacterial diseases.**

Fungi

- **Fungi attack plants that are important to people.**
  - **Fungi cause the majority of plant diseases, and some of the plants that they infect are important to humans.**
  - **Especially damaging are plant pests called rusts and smuts, which cause billions of dollar's worth of damage to grain crops annually.**



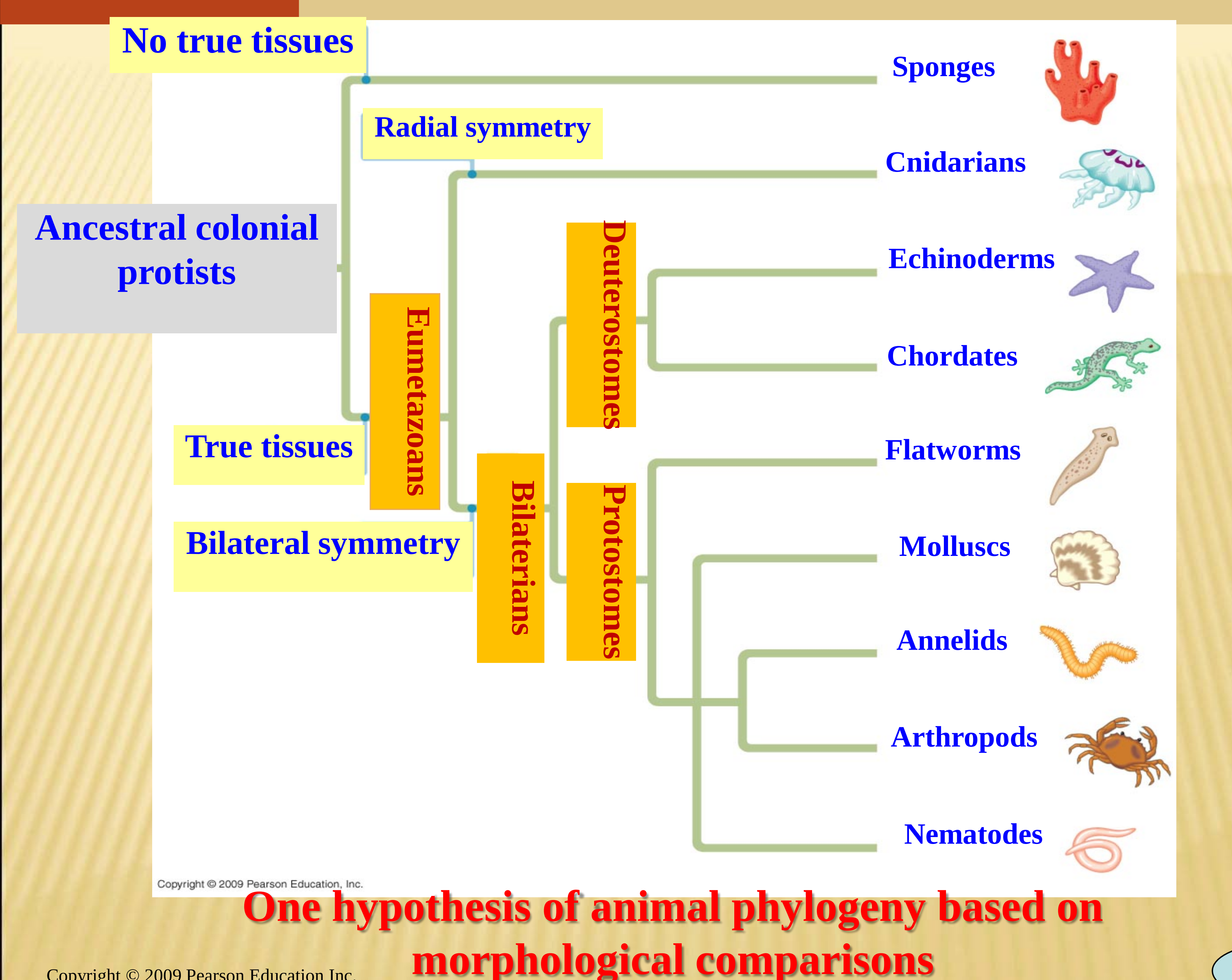
Corn smut

Fungi

- **Fungi include parasites that attack humans directly.**
  - **Some of these are athlete's foot, jock itch, vaginal infections and ringworm.**
- **Fungi can produce toxins.**
  - **Molds of the genus *Aspergillus* produce highly toxic, carcinogenic compounds known as aflatoxins.**
  - **Some foods, such as peanuts, seem to be especially susceptible to attack by *Aspergillus*.**

Animals

- **Characteristics of animals**
  - **Animals are multicellular.**
  - **Animals get their energy by consuming other organisms.**
  - **Animals reproduce sexually.**
  - **Animal cells lack a cell wall.**
  - **Animals are mobile.**
  - **Animals react rapidly to external stimuli.**



One hypothesis of animal phylogeny based on morphological comparisons

Animals

- For convenience, animals are categorized as:
  1- Vertebrates (with backbones)
  2- Invertebrates (without backbones).
- Sponges
  - Sponges have a simple body plan, lack tissues or organs, and are colonies of single-celled organisms.


(a) Encrusting sponge


(b) Tubular sponge

Animals

- **Sponges**
  - **Water enters through numerous tiny pores in the body, and leaves through fewer, large openings.**
  - **Oxygen and food is filtered out of the water during passage.**
  - **Reproduction can be asexual through budding, or sexual by the release of eggs and sperm into the water.**

Animals

- **Arthropods are the dominant animals on Earth.**
  - **Arthropoda includes:**

    1- Insects

    2- Arachnids,

    3- Crustaceans.
  - **They all have an exoskeleton; in insects, the body is divided into three parts: head, thorax, and abdomen.**
  - **Insects are the only flying invertebrates.**

Animals

- **Insects**
  - **During their development, insects undergo metamorphosis, a radical change from a juvenile body form to an adult body form.**
    - **Larva is the immature stage of the insect, which grows until it reaches maximum size.**
    - **It then forms a non-feeding stage called a pupa.**
    - **An adult emerges from the pupa.**



(a) Aphid



(b) Beetles mating



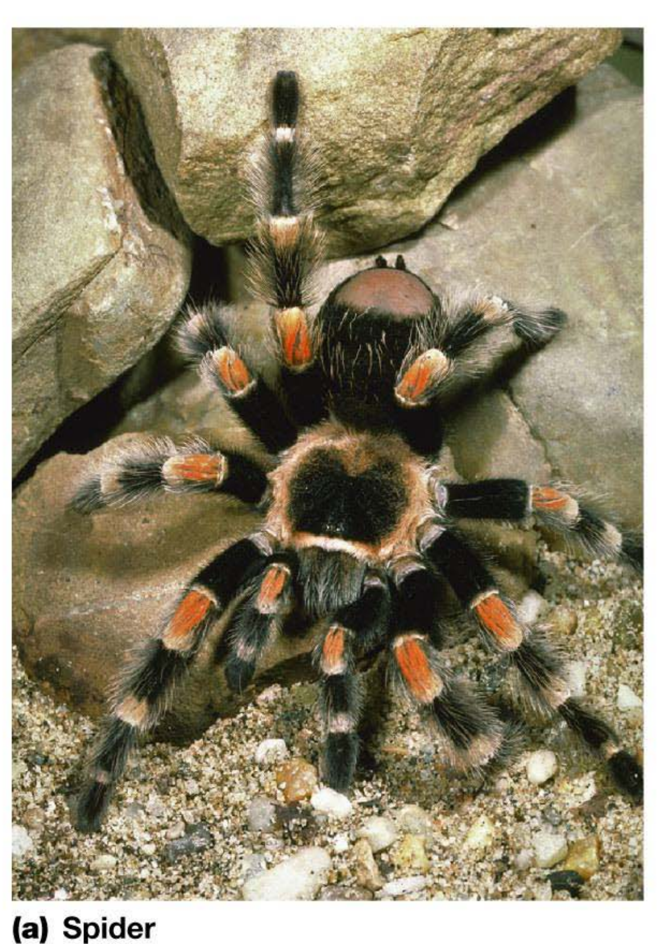
(c) Beetle flying خنفساء طائرة



(d) Moth larva يرقة العث

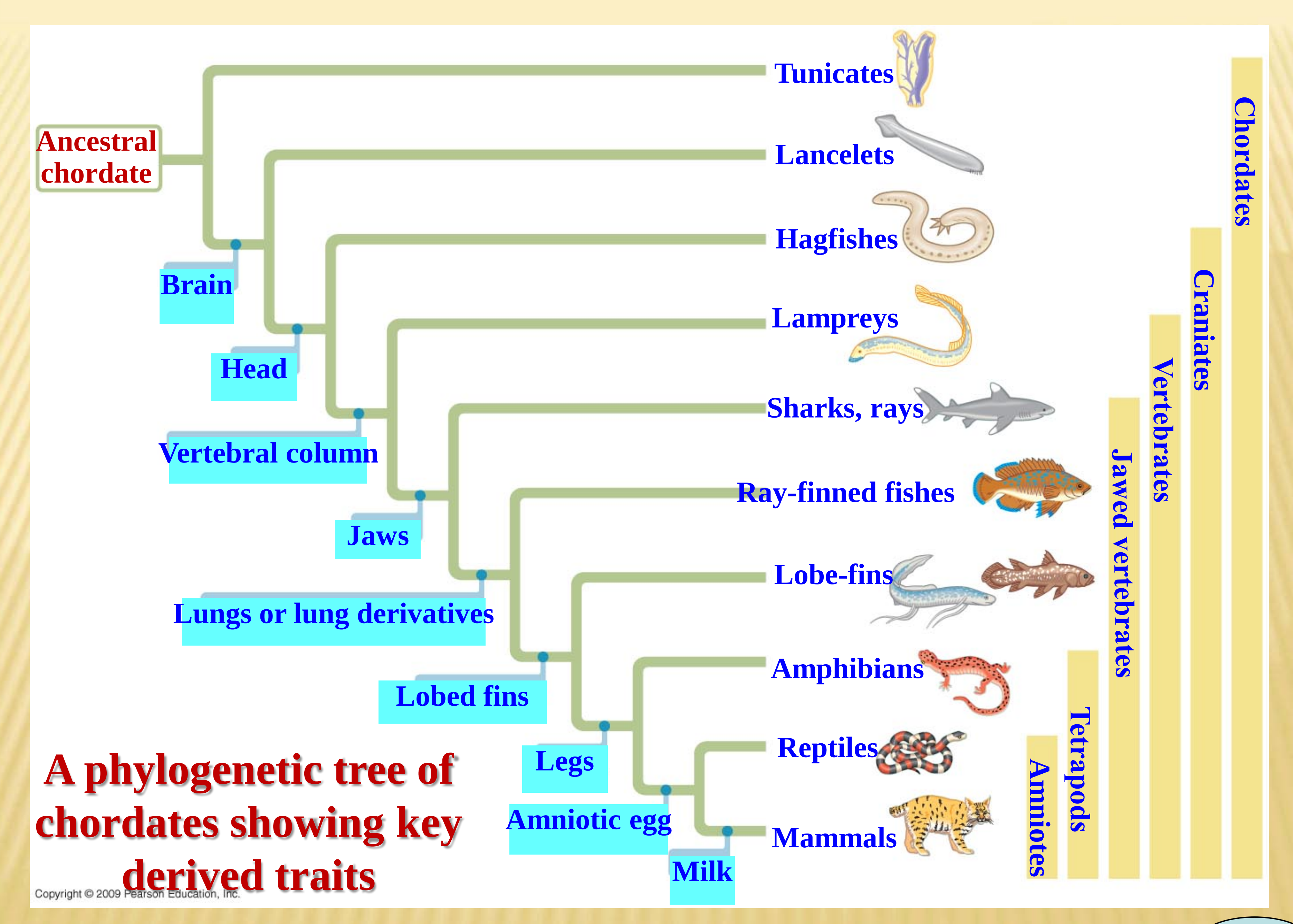
Animals

- The arachnids include spiders, mites, ticks, and scorpions.


(a) Spider


(b) Scorpion


(c) Ticks

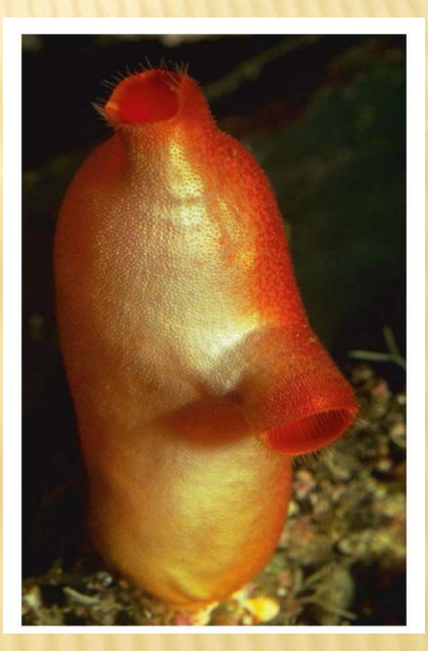

Tunicates
Lancelets
Hagfishes
Lampreys
Sharks, rays
Ray-finned fishes
Lobe-fins
Amphibians
Reptiles
Mammals
Ancestral chordate
Brain
Head
Vertebral column
Jaws
Lungs or lung derivatives
Lobed fins
Legs
Amniotic egg
Milk
Chordates
Craniates
Vertebrates
Jawed vertebrates
Tetrapods
Amniotes
A phylogenetic tree of chordates showing key derived traits
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Animals

- **Chordates include both invertebrates and vertebrates.**
- **They have the following features:**
  - **The notochord: a stiff, flexible rod that extends the length of the body and provides attachment for muscles.**
  - **The nerve cord: a dorsal hollow tube; one end becomes the brain during development.**
  - **Pharyngeal gill slits: these may develop into functional gills or just remain as grooves in early development**
  - **A post-anal tail: extends beyond the body, past the anus**

Animals

- **The invertebrate chordates live in the seas.**
  - **The invertebrate chordates are the lancelets and the tunicates.**
  - **Larvae of lancelets lack a backbone, but adults possess all four chordate features.**
  - **The tunicates (sea squirts) have a larva that swims and has all chordate features.**
  - **Adults are attached to the sea bottom and do not move.**



Sea squirt

Animals

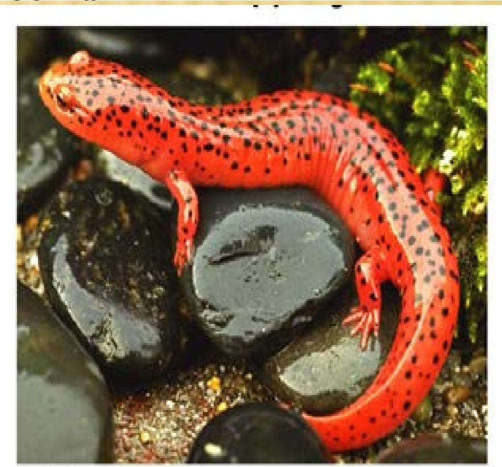
- **Vertebrates have a backbone.**
  - **For vertebrates, the embryonic notochord is normally replaced during development by a backbone, or vertebral column.**
  - **Vertebrates are represented by fish, amphibians, reptiles, birds and mammals**
  - **There are more ray-finned fishes than any of the other vertebrate groups.**

Animals

- **Amphibians**
  - They straddle the boundary between aquatic and terrestrial existence.
  - They have a three-chambered heart.
  - Lungs are poorly developed and they are supplemented by skin respiration.
  - They reproduce in water; many undergo metamorphosis with aquatic larval forms and terrestrial adults.


(a) Tadpole


(b) Frog


(c) Salamander

Animals

- **Reptiles**
  - **They include lizards, snakes, turtles, alligators and crocodiles.**
  - **Many species are completely independent of water as a result of three adaptations:**
    - **Evolution of a tough, scaly skin that resists water loss and protects the body**
    - **Evolution of internal fertilization**
    - **Evolution of a shelled egg**


(a) Snake


(b) Alligator


(c) Tortoise

Animals

- **Birds**
  - One very distinctive group of reptiles is the birds.
  - Birds have developed feathers, which are highly specialized versions of reptilian scales.
  - Modern birds retain scales on their legs as evidence of the ancestry they share with reptiles
  - Birds have hollow bones for flight, and produce a shelled egg.


(a) Hummingbird


(b) Frigate bird

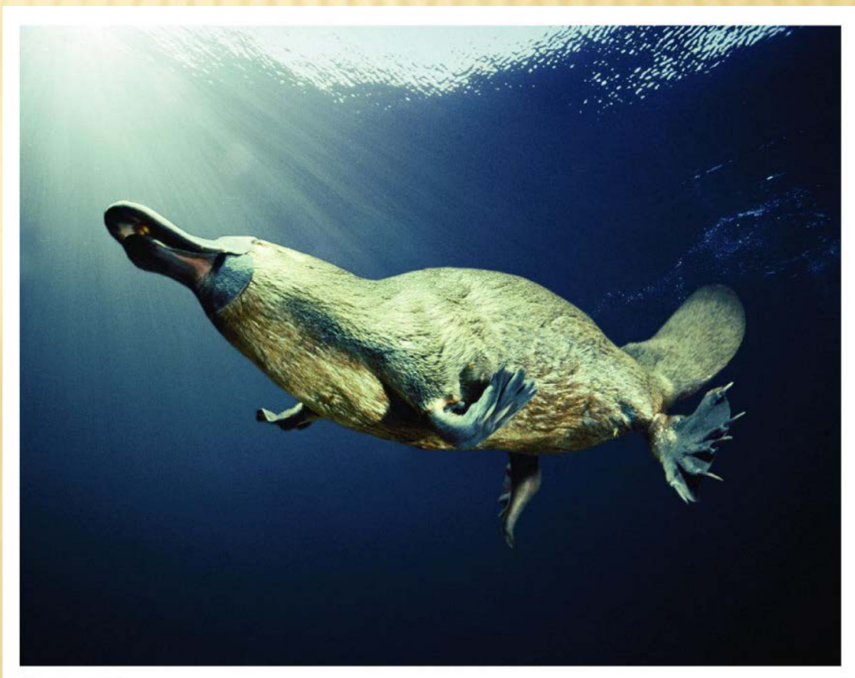

(c) Ostrich

Animals

- **Mammals**
  - **One branch of reptiles gave rise to a group that evolved hair and diverged to form the mammals.**
  - **Mammals are named for the milk-producing mammary glands used by female members of the group to suckle their young.**
  - **In most mammals, fur protects and insulates the warm body.**
  - **The mammals are divided into three groups: monotremes, marsupials and placentals.**

Animals

- **Mammals**
  - **Monotremes are found only in Australia and New Guinea, and include the platypus and two species of spiny anteaters, also known as echidnas.**
  - **Monotremes lay eggs.**


(a) Platypus

Animals

- **All mammals except monotremes have embryos that develop in the uterus of the female reproductive tract.**
  - **In marsupials, embryos are only in the uterus for a short time and are then born at a very immature stage of development.**
  - **Immediately after birth, they crawl to a nipple, firmly grasp it, and complete their development.**
  - **In many marsupial species, this post birth development takes place in a protective pouch.**

Animals

- **Marsupials**



(b) Wallaby

Animals

- **Most mammal species are placental mammals.**
  - **Compared to marsupials, placental mammals retain their young in the uterus for a much longer period, so that offspring complete their embryonic development before being born.**
  - **The bat, mole, impala, whale, seal, monkey, and cheetah exemplify the radiation of mammals into nearly all habitats, with bodies adapted to their varied lifestyles.**
  - **The largest group of placental mammals are the bats and rodents.**

Animals

- **Placental mammals**


(c) Whale


(d) Bat

Chapter 8

NUTRITION and DIGESTION

Topics Discussed in this chapter

- **The Nutrition & Digestion Lecture materials include:**
  - **What is nutrition?**
  - **What is digestion?**
  - **Kinds of diets**
  - **Ways of ingesting food**
  - **Stages of food processing**
  - **Human digestive system & digestion**
  - **Nutrition**
  - **Practice test questions**
  - **Glossary**

What is nutrition?

It is the science of the nutrients and "other substances" in food:

- **Their action, interaction, and balance in relation to health and disease**
- **The processes by which the organism ingests, digests, absorbs, transports, utilizes and excretes food substances**

Nutrients

- **Substances that we must have in our diets in order for our cells to function properly**

- **Include:**
  - **Proteins**
  - **Carbohydrates**
  - **Lipids**
  - **Vitamins**
  - **Minerals**
  - **Water**

Digestion

How do we get nutrients from food?

OBTAINING AND PROCESSING FOOD

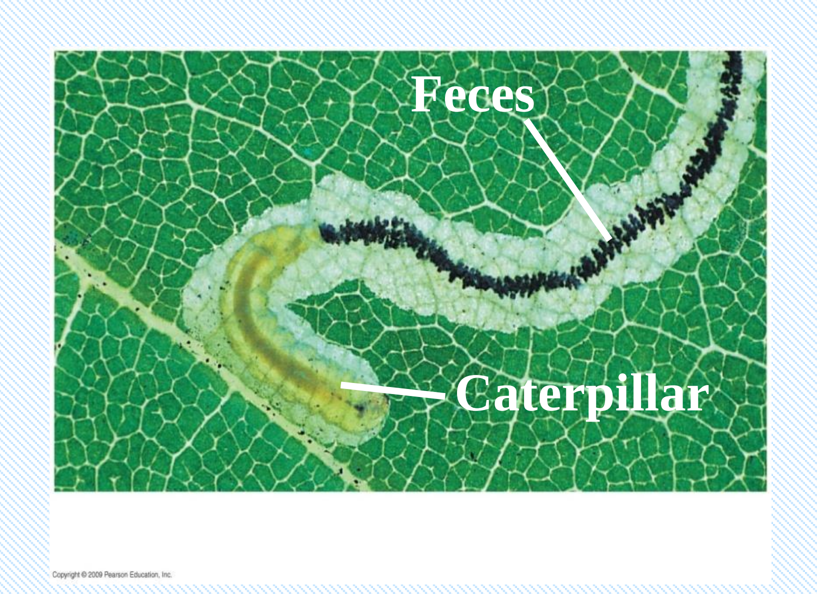
Kinds of diets

- **Most animals have one of three kinds of diets**

  1) **Herbivores**, plant-eaters — cattle, snails and sea urchins
  2) **Carnivores**, meat-eaters — lions, hawks and spiders
  3) **Omnivores**, eating both plants and other animals — humans, roaches, raccoons and crows

Animals ingest their food in a variety of ways

- **Animals obtain and ingest their food in different ways**
  1) **Suspension feeding**
  2) **Substrate feeding**
  3) **Fluid feeding**
  4) **Bulk feeding**





A substrate feeder:

a caterpillar eating its way through the soft green tissues inside an oak leaf.

A suspension feeder:

a tube worm filtering food from the surrounding water through its tentacles.



A fluid feeder:

a mosquito sucking blood.



A bulk feeder:

a grey heron preparing to swallow a fish head first and the rest next.

Stages of food processing

- **Food is processed in four stages**

  1) **Ingestion**
  2) **Digestion**
  3) **Absorption**
  4) **Elimination**

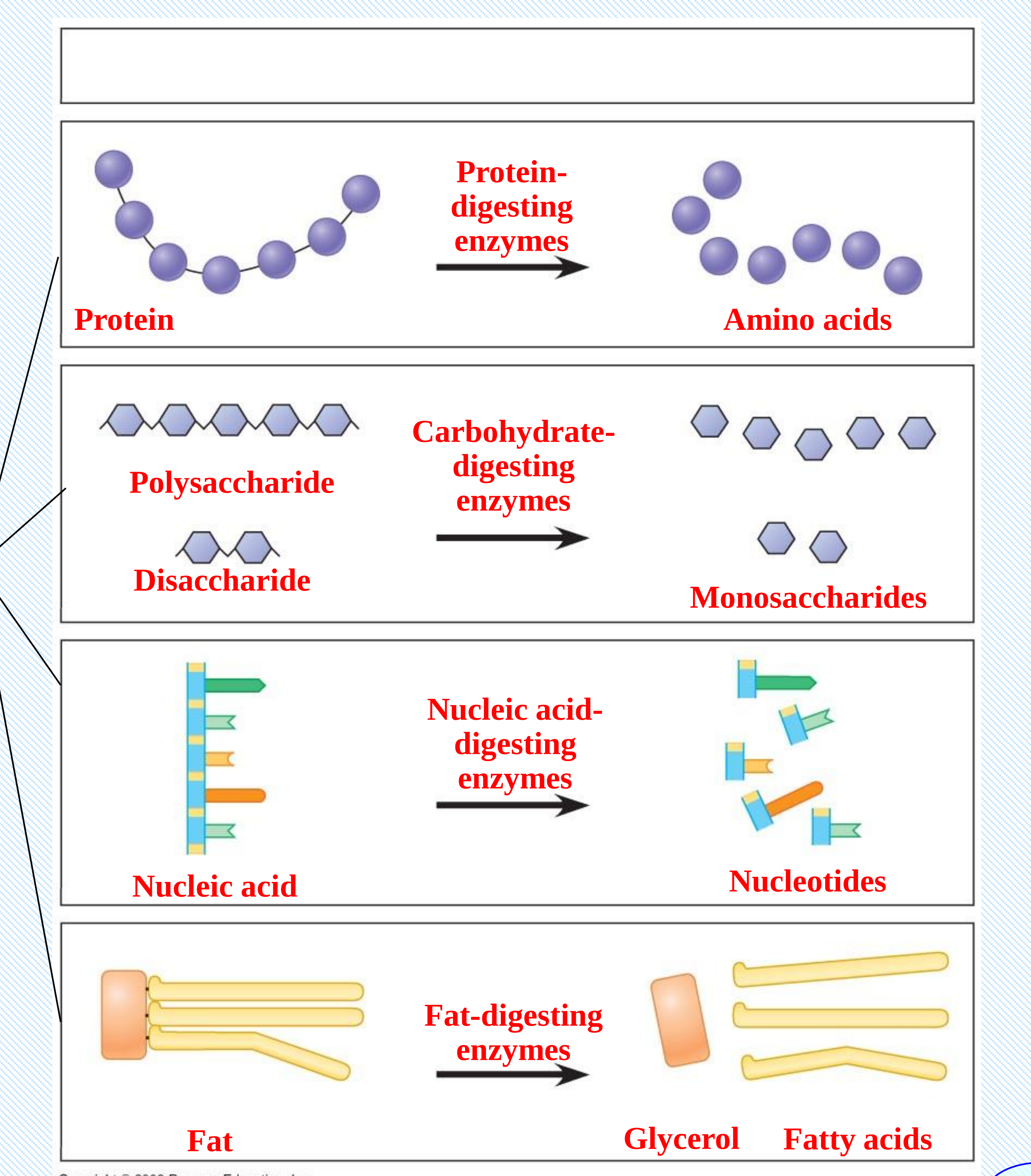
Digestion

There are two types of digestion

1. **Mechanical digestion: breaks food down into smaller pieces**

2. **Chemical digestion: enzymatic break down of large organic molecules into their components**

Chemical digestion



HUMAN DIGESTIVE SYSTEM

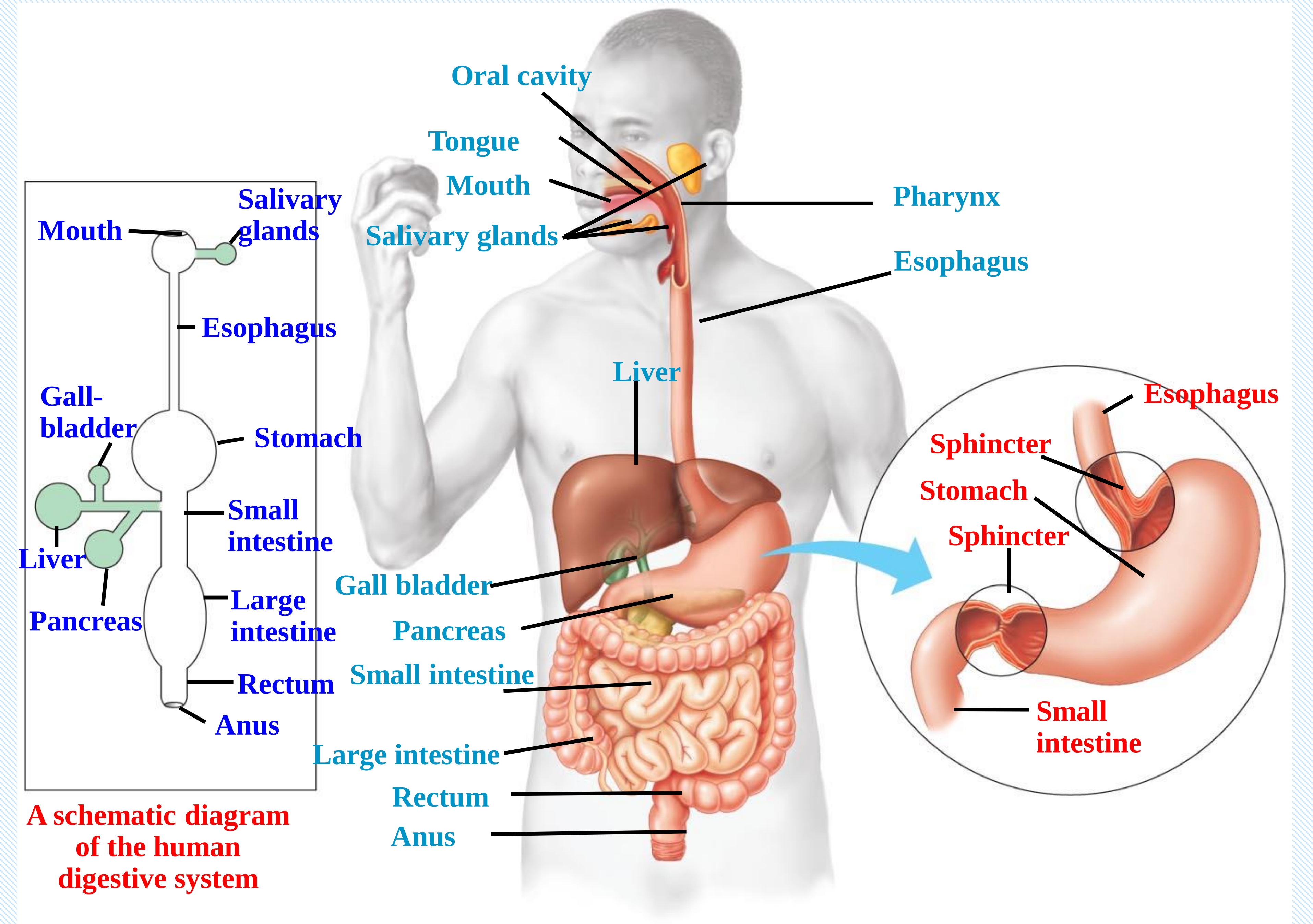
- **Human digestive system consists of:**

1) **An alimentary canal**

Mouth, pharynx, esophagus, stomach, small intestine, large intestine also known as the colon, rectum and anus.

2) **Accessory glands**

    - **Salivary glands → salivary amylase**
    - **Pancreas → Pancreatic amylase, chymotrypsin, trypsin, lipases and nucleases**
    - **Liver → bile and bile salts**
    - **Gallbladder → bile storage**

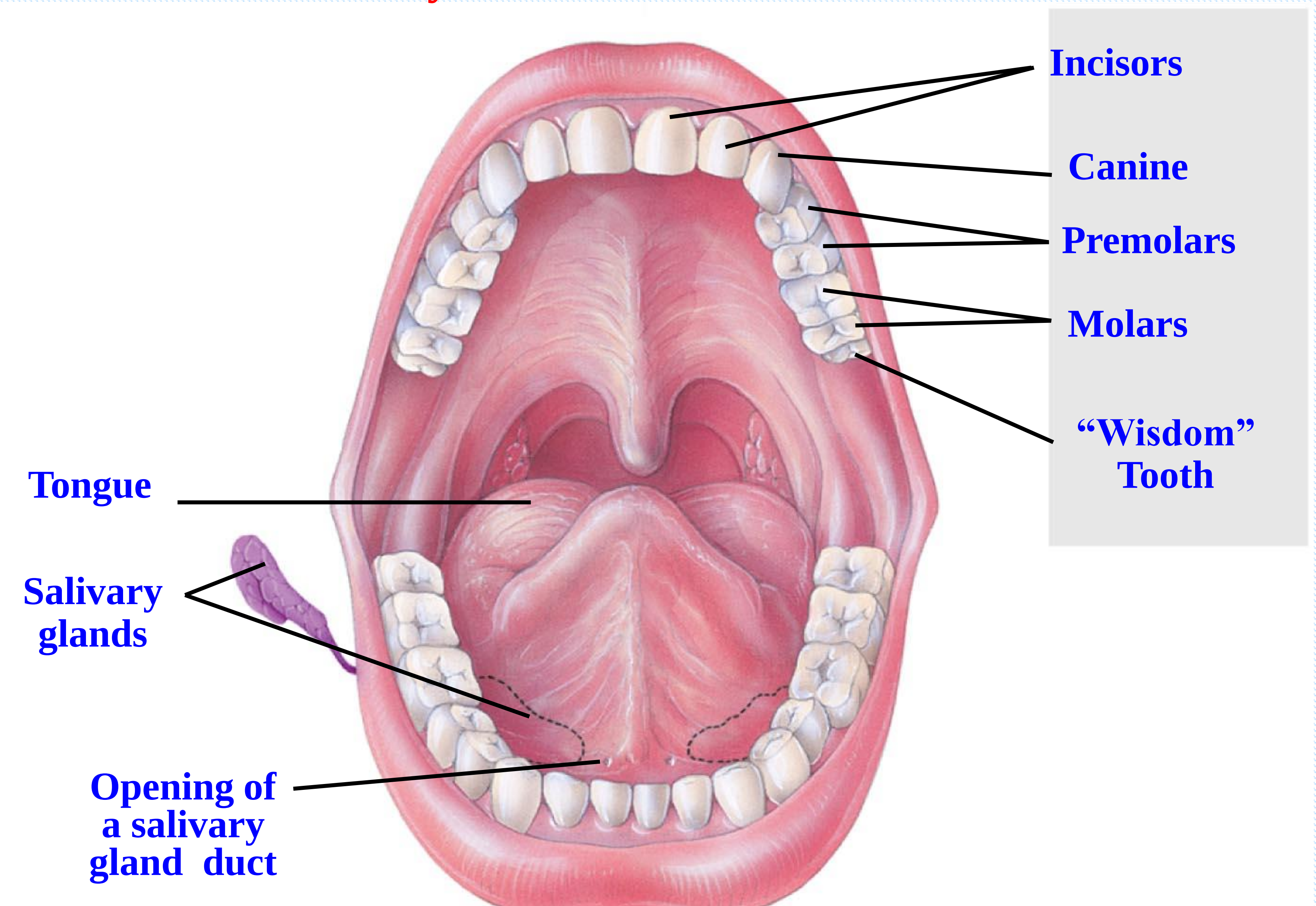


The human digestive system

Process of Digestion

- **Mechanical – Chewing and mixing of food occurs in the mouth and stomach**
- **Teeth break up food, saliva moistens it**
  - **Salivary amylase begins the hydrolysis of starch**
  - **Antibacterial agent kills some bacteria ingested with food**
- **The tongue tastes, shapes the bolus of food, and moves it towards the pharynx.**

The human oral cavity

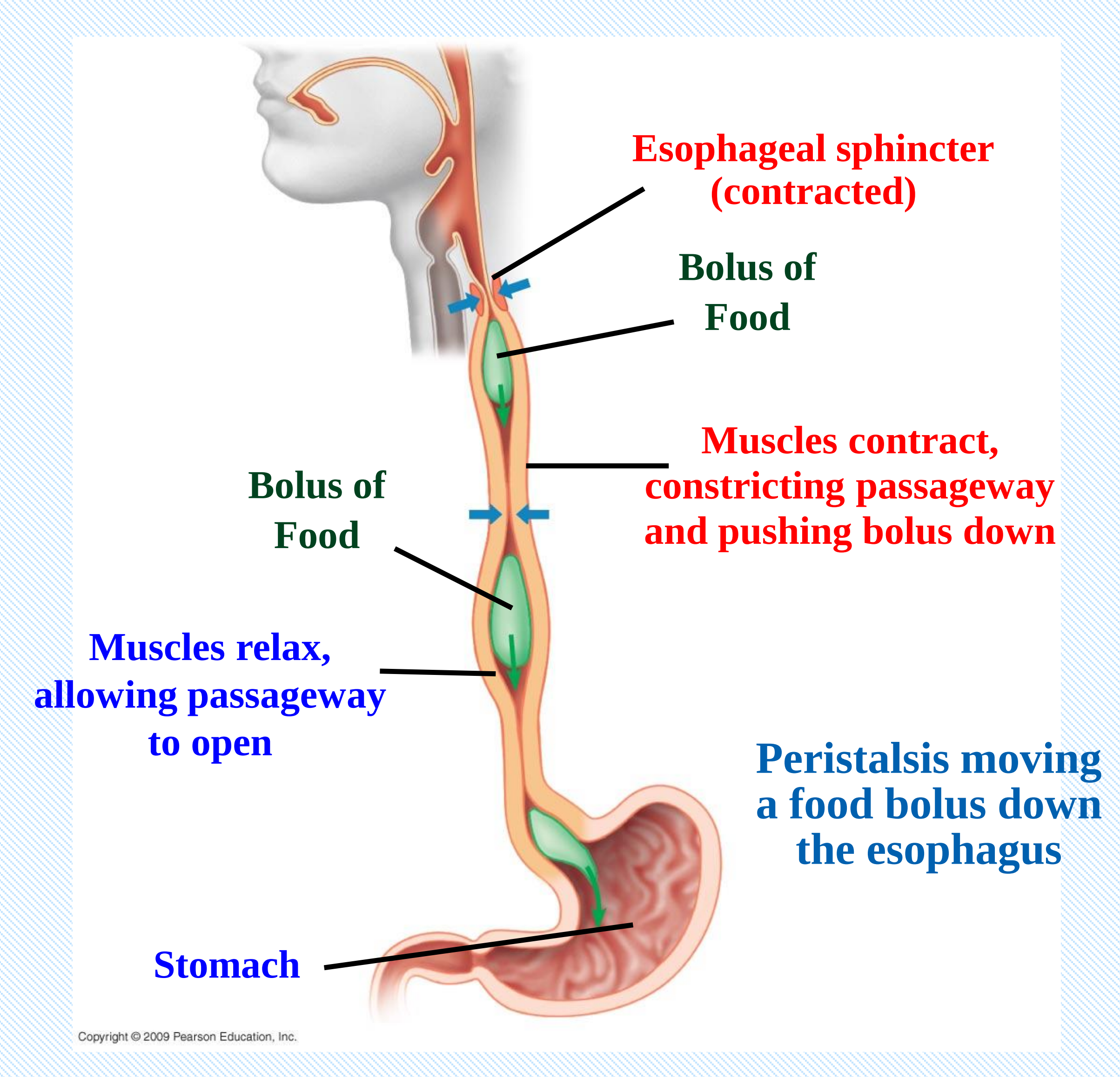


Food movement in the alimentary canal

- Esophagus serves to transport food from mouth to stomach
- Alternating waves of contraction and relaxation by smooth muscle in the walls of the canal move food along in a process called peristalsis
- Sphincters - a circular muscle arrangement that acts as a valve to regulate passage or flow of food into and out of digestive chambers.
- The pyloric sphincter
  - Regulates the passage of food from the stomach to the small intestine
  - Limits the upward movement of acids into the esophagus

Peristalsis moves food through the esophagus to the stomach

- After swallowing, peristalsis moves food through the esophagus to the stomach
- The trachea conducts air to the lungs
- The esophagus conducts food from the pharynx to the stomach



The stomach stores food and breaks it down with acid and enzymes

- **In the stomach**
  - **Parietal cells produce Acid HCl - pH = 2**

    Acid kills bacteria and breaks apart cells in food
  - **Chief cells produce Pepsinogen (inactive).**

    Pepsinogen + HCl ------ pepsin (active).

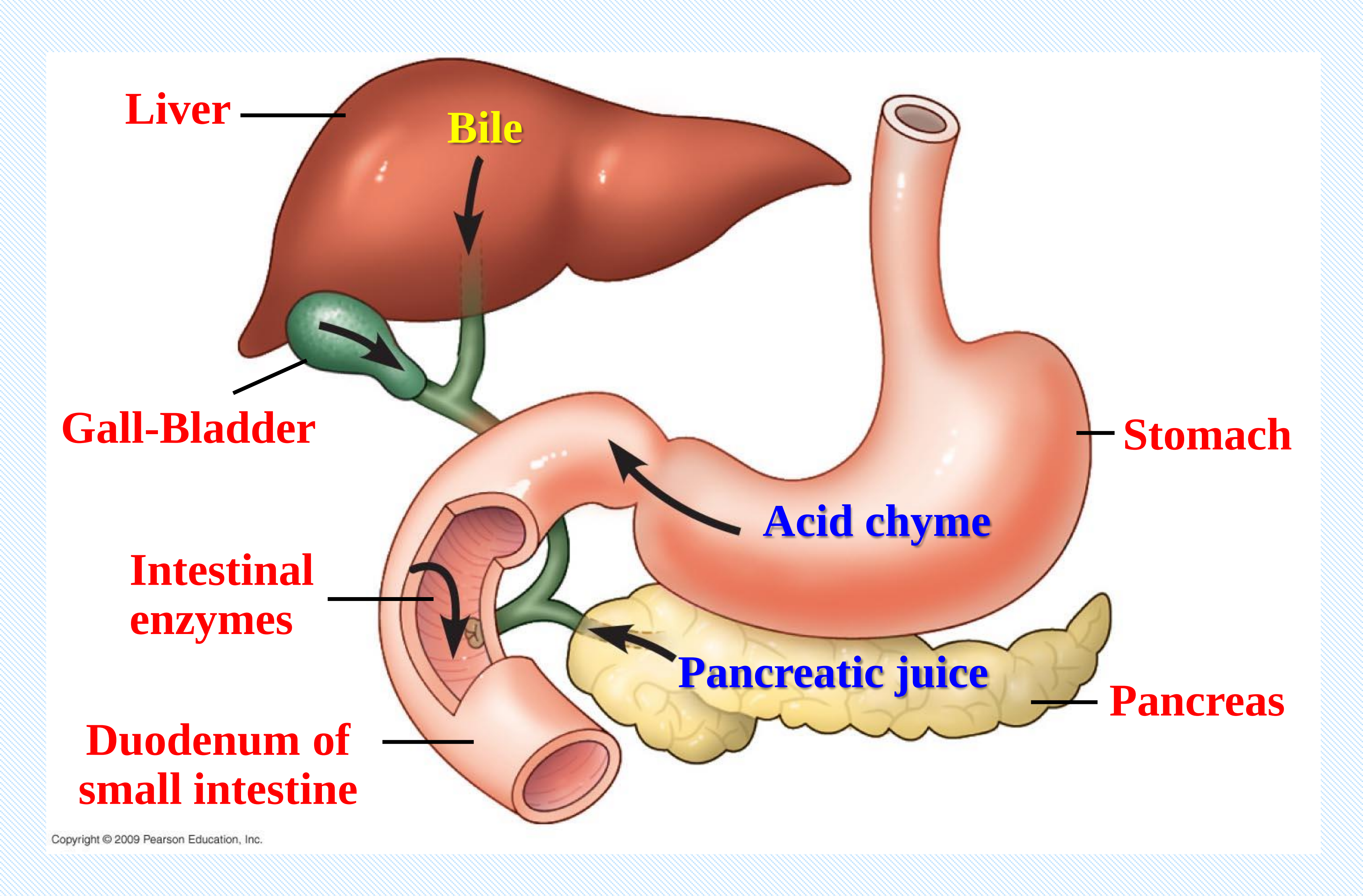
    Pepsin begins the chemical digestion of proteins
  - **Mucous production:** **helps protect cell wall against HCl and pepsin, cells lining the stomach are renewed about every 3 days**
  - **Acidic gastric juices mix with food to produce acid chyme**

In the small intestine

- Small intestine is the major organ of chemical digestion and nutrient absorption
- Small intestine is named for its smaller diameter — it is about 6 meters long
- Alkaline pancreatic juice neutralizes acid chyme and its enzymes

(pancreatic amylase, lipase, proteases and nucleases) digest food

- Bile, made in the liver and stored in the gall bladder, emulsifies fat for attack by pancreatic lipase



The small intestine and related digestive organs

TABLE 21.10 ENZYMATIC DIGESTION IN THE SMALL INTESTINE

Substrate	Enzyme	Product	Enzyme	Final product
Carbohydrates				
Starch	Pancreatic amylase →	Maltose (and other disaccharides)	Maltase, sucrase, lactase, etc. →	Monosaccharides
Proteins				
Polypeptides	Trypsin, chymotrypsin →	Smaller polypeptides	Aminopeptidase, carboxypeptidase, dipeptidase →	Amino acids
Nucleic acids				
DNA and RNA	Nucleases →	Nucleotides	Other enzymes →	Nitrogenous bases, sugars, and phosphates
Fats				
Fat globules	Bile salts →	Fat droplets (emulsified)	Lipase →	Fatty acids and glycerol

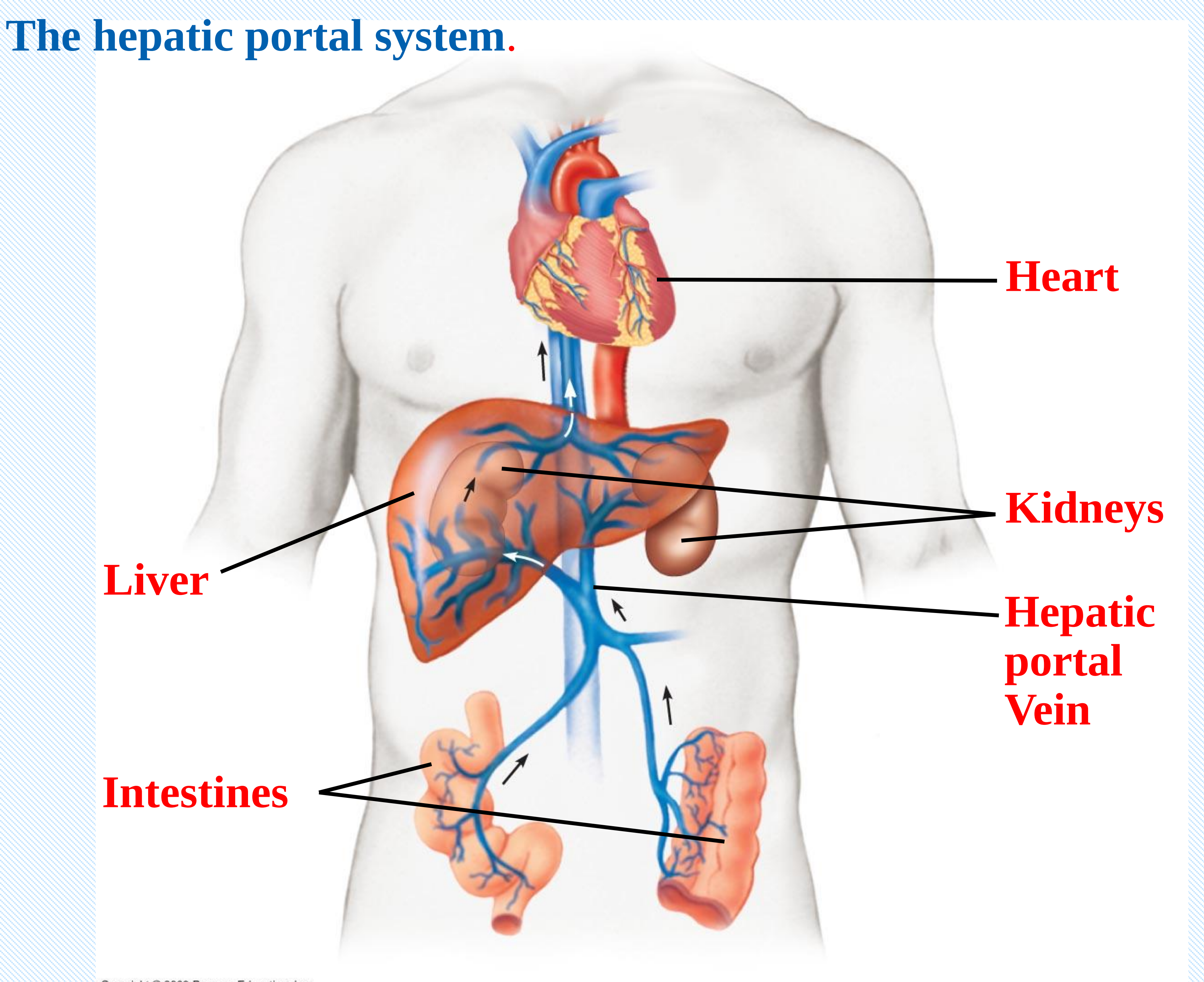
The small intestine is the major organ of chemical digestion and nutrient absorption

- Surface area for absorption is increased by
  - Folds of the intestinal lining
  - Finger-like villi
- Nutrients pass across the epithelium and into blood
- Blood flows to the liver where nutrients are processed and stored

Liver's functions

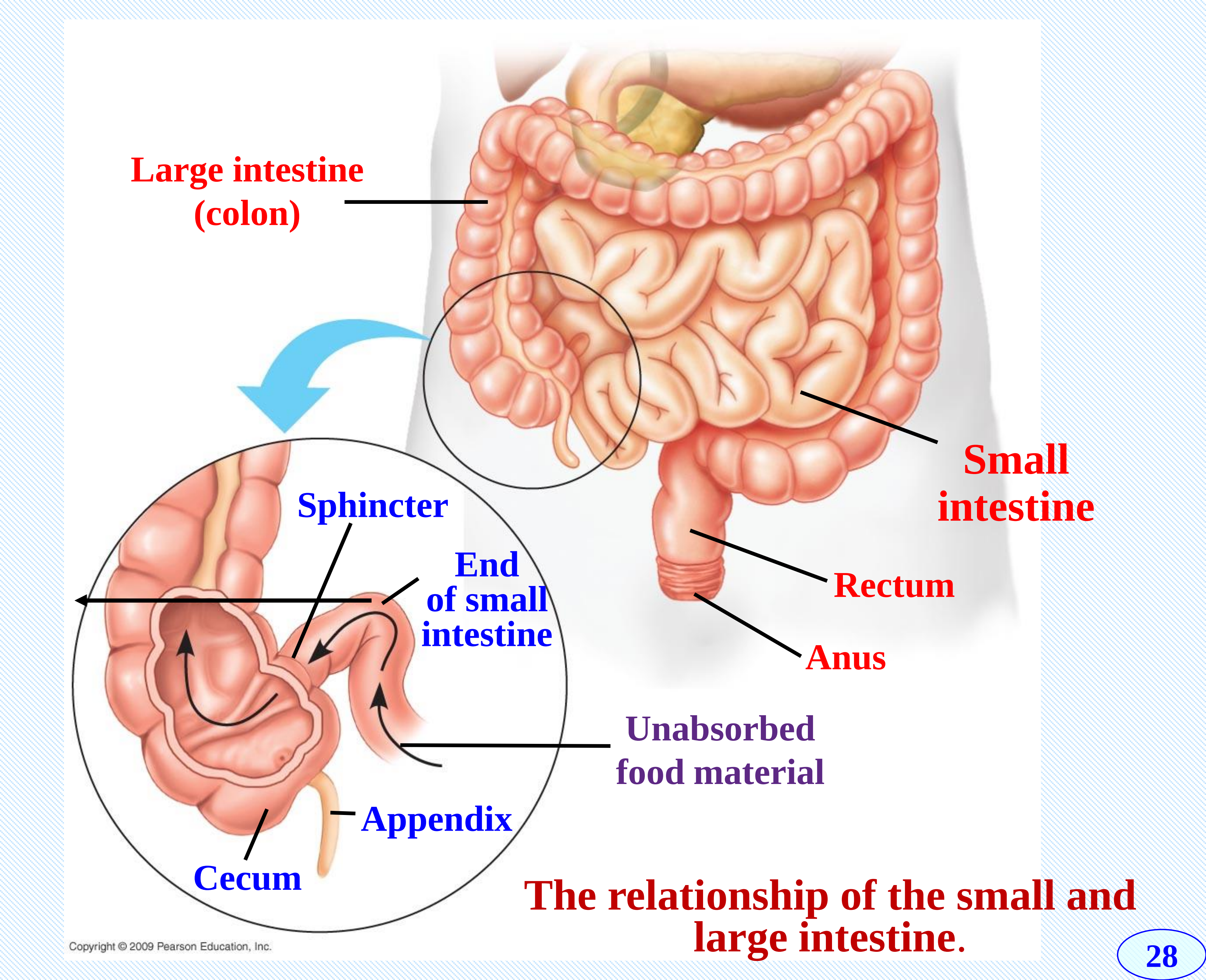
- **Blood from the digestive tract drains to the liver**
- **The liver functions:**
  1) **Glucose in blood is converted to glycogen and stored in the liver**
  2) **Liver synthesizes many proteins including blood clotting proteins and lipoproteins that transport fats and cholesterol**
  3) **Liver changes toxins to less toxic forms**
  4) **Liver produces bile**
- **Storage**
- **Nutrients not used can be stored as**
  Glycogen
  Fat

The hepatic portal system.



The large intestine reclaims water and compacts the feces

- **Diarrhea occurs when too little water is reclaimed**
- **Constipation occurs when too much water is reclaimed**
- **Feces are stored in the rectum**
- **Colon bacteria produce vitamins — biotin, vitamin K & B vitamins**
- **Appendix**
  - **Located near the junction of the small intestine and colon**
  - **Makes a minor contribution to immunity**



The relationship of the small and large intestine.

NUTRITION

A healthy diet satisfies three needs

1) Fuel to power the body

2) Organic molecules to build molecules

3) Essential nutrients — raw materials that animals cannot make for themselves like vitamins, minerals and the essential amino acids (animals cannot produce eight of the 20 amino acids named essential amino acids. These eight amino acids must come from the diet)

Chemical energy powers the body

- **Nutrients are oxidized inside cells to make ATP**
- **Proteins, carbohydrates, and fats are the main sources of calories**
- **Basal metabolic rate (BMR): energy a resting animal requires each day**
- **Metabolic rate: BMR plus the energy needed for physical activity**
- **Excess energy is stored as glycogen or fat**
- **Our metabolic rates typically decrease throughout adulthood**

- **Unhealthy diet**

  Unhealthy diets are linked to:

  - Undernourishment — not enough calories

  - Malnourishment — missing essential nutrients

- **A healthy diet includes 13 vitamins and many essential minerals**

  - **Essential vitamins and minerals**
    - **Required in minute amounts**
    - **Extreme excesses can be dangerous**
    - **Excess water-soluble vitamins can be eliminated in urine**
    - **Excess fat-soluble vitamins accumulate to dangerous levels in body fat**

Essential vitamins

- **Main function is to allow chemical reactions to occur in body**
  - **Required in minute amounts**
    - **Help release energy trapped in carbohydrates, lipids and proteins**
- **13 vitamins divided into 2 groups:**
  - **Fat soluble- A, D, E, K**
  - **Water soluble- C and B vitamins**

Minerals

- **Minerals are simple inorganic nutrients include:**
- **Na+, K^+ and Mg^{++} which usually required in small amounts**
- **Ca^{++} and $PO4^{3-}$ which are required in larger amounts**
- **They are critical for nervous system function, maintaining electrolyte levels, water balance, and skeletal system**

A Vitamin Requirements of Humans

TABLE 21.18A VITAMIN REQUIREMENTS OF HUMANS

Vitamin	Major Dietary Sources	Functions in the Body	Symptoms of Deficiency / Symptoms of Extreme Excess
Water-Soluble Vitamins			
Vitamin B_1 (thiamine)	Pork, legumes, peanuts, whole grains	Coenzyme used in removing CO_2 from organic compounds	Beriberi (nerve disorders, emaciation, anemia)
Vitamin B_2 (riboflavin)	Dairy products, meats, enriched grains, vegetables	Component of coenzyme FAD	Skin lesions such as cracks at corners of mouth
Niacin (B_3)	Nuts, meats, grains	Component of coenzymes NAD^+ and $NADP^+$	Skin and gastrointestinal lesions, nervous disorders Liver damage
Vitamin B_6 (pyridoxine)	Meats, vegetables, whole grains	Coenzyme used in amino acid metabolism	Irritability, convulsions, muscular twitching, anemia Unstable gait, numb feet, poor coordination
Pantothenic acid (B_5)	Most foods: meats, dairy products, whole grains, etc.	Component of coenzyme A	Fatigue, numbness, tingling of hands and feet
Folic acid (folacin) (B_9)	Green vegetables, oranges, nuts, legumes, whole grains	Coenzyme in nucleic acid and amino acid metabolism; neural tube development in embryo	Anemia, gastrointestinal problems May mask deficiency of vitamin B_{12}
Vitamin B_{12}	Meats, eggs, dairy products	Coenzyme in nucleic acid metabolism; maturation of red blood cells	Anemia, nervous system disorders
Biotin	Legumes, other vegetables, meats	Coenzyme in synthesis of fat, glycogen, and amino acids	Scaly skin inflammation, neuromuscular disorders
Vitamin C (ascorbic acid)	Fruits and vegetables, especially citrus fruits, broccoli, cabbage, tomatoes, green peppers	Used in collagen synthesis (e.g., for bone, cartilage, gums); antioxidant; aids in detoxification; improves iron absorption	Scurvy (degeneration of skin, teeth, blood vessels), weakness, delayed wound healing, impaired immunity Gastrointestinal upset
Fat-Soluble Vitamins			
Vitamin A (retinol)	Dark green and orange vegetables and fruits, dairy products	Component of visual pigments; maintenance of epithelial tissues; antioxidant; helps prevent damage to cell membranes	Vision problems; dry, scaly skin Headache, irritability, vomiting, hair loss, blurred vision, liver and bone damage
Vitamin D	Dairy products, egg yolk (also made in human skin in presence of sunlight)	Aids in absorption and use of calcium and phosphorus; promotes bone growth	Rickets (bone deformities) in children; bone softening in adults Brain, cardiovascular, and kidney damage
Vitamin E (tocopherol)	Vegetable oils, nuts, seeds	Antioxidant; helps prevent damage to cell membranes	None well documented; possibly anemia
Vitamin K	Green vegetables, tea (also made by colon bacteria)	Important in blood clotting	Defective blood clotting Liver damage and anemia

CONNECTION: Diet can influence cardiovascular disease and cancer

- **A healthy diet may reduce the risk of cardiovascular disease and cancer**
- **Two main types of cholesterol**
  - **LDL : contributes to blocked blood vessels and higher blood pressure**
  - **HDL : tends to reduce blocked blood vessels**
- **Exercise increases HDL levels**
- **Smoking decreases HDL levels**

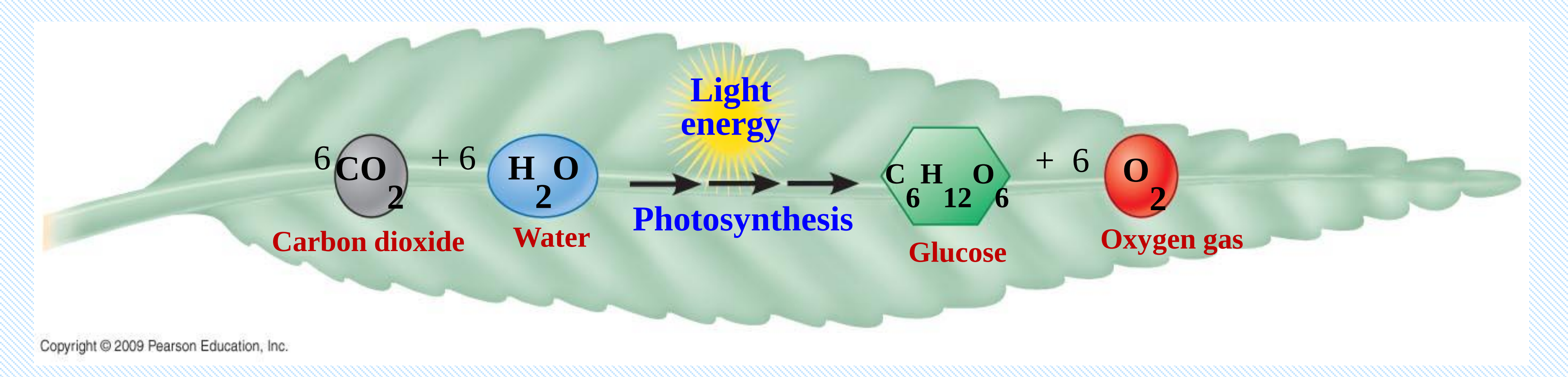
Plant Nutrition and Transport

Plant Nutrition and Transport

The **uptake** and **transport** of plant nutrients

Plants acquire their nutrients from soil and air

- Plants take up carbon dioxide from the air to produce sugars via photosynthesis; oxygen is produced as a product of photosynthesis

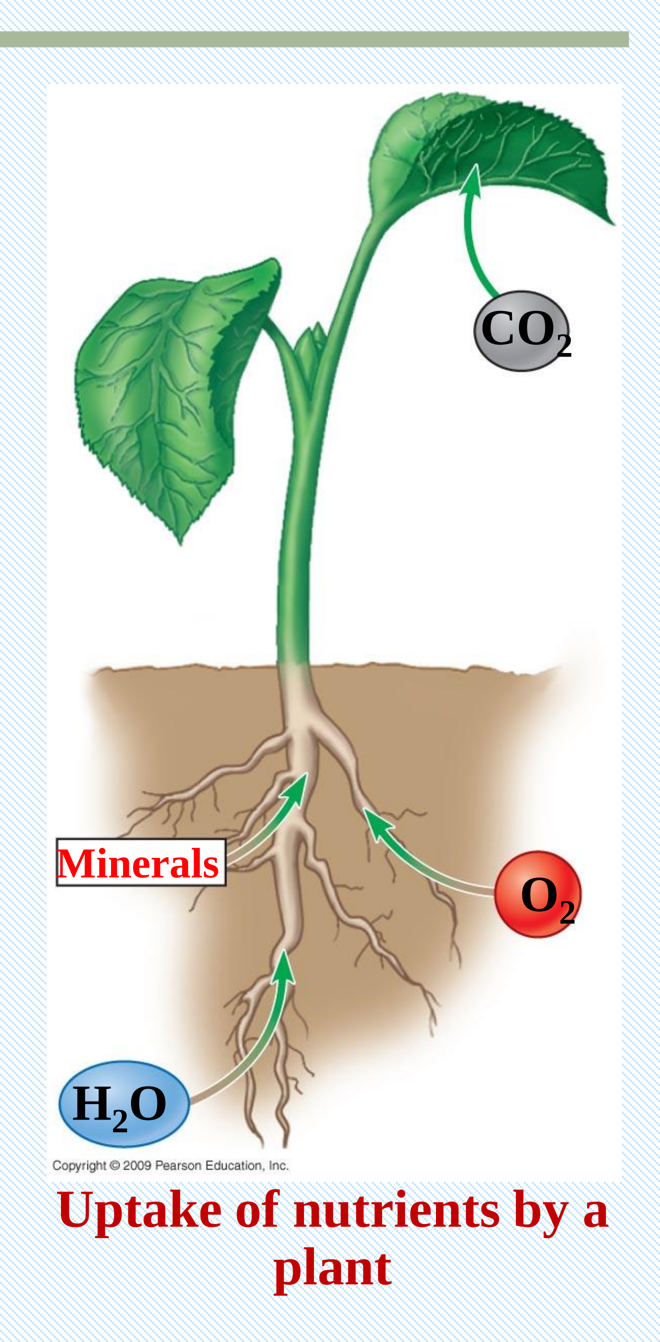


- Plants obtain water, minerals, and some oxygen from the soil. Using simple sugars as an energy source and as building blocks, plants convert the inorganic molecules they take up into the organic molecules of living plant tissue

Plants acquire their nutrients from soil and air

- **Inorganic molecules taken up by plants**
  - Carbon dioxide
  - Nitrogen
  - Magnesium
  - Phosphorus

- **Organic molecules produced by plants**
  - Carbohydrates
  - Lipids
  - Proteins
  - Nucleic acids



Uptake of nutrients by a plant

The plasma membranes of root cells control solute uptake

- Minerals taken up by plant roots are in a watery solution
- Water and minerals are absorbed through the epidermis of the root and must be taken up by root cells before they enter the xylem
- Selective permeability of the plasma membrane of root cells controls what minerals enter the xylem

Pathways by which water and minerals enter the xylem

- **There are two pathways by which water and minerals enter the xylem**
  1) **Intracellular route: water and solutes are selectively taken up by a root epidermal cell, usually a root hair, and transported from cell to cell through plasmodesmata**
  2) **Extracellular route: water and solutes pass into the root in the porous cell walls of root cells; they do not enter any cell plasma membrane until they reach the root endodermis**
- **The cells of the endodermis contain a waxy barrier called the Casparian strip**
  - **Specialized cells of the endodermis take up water and minerals selectively**
  - **The Casparian strip regulates uptake of minerals that enter the root via the extracellular route**



Root hairs of radish seedling

Routes of water and solutes from soil to root xylem

Key
Dermal tissue system
Ground tissue system
Vascular tissue system

Root hair
Epidermis
Cortex
Phloem
Xylem
Casparian strip
Endodermis

Extracellular route, via cell walls; stopped by Casparian strip

Casparian strip
Xylem
Root hair
Plasmodesmata

Intracellular route, via cell interiors, through plasmodesmata

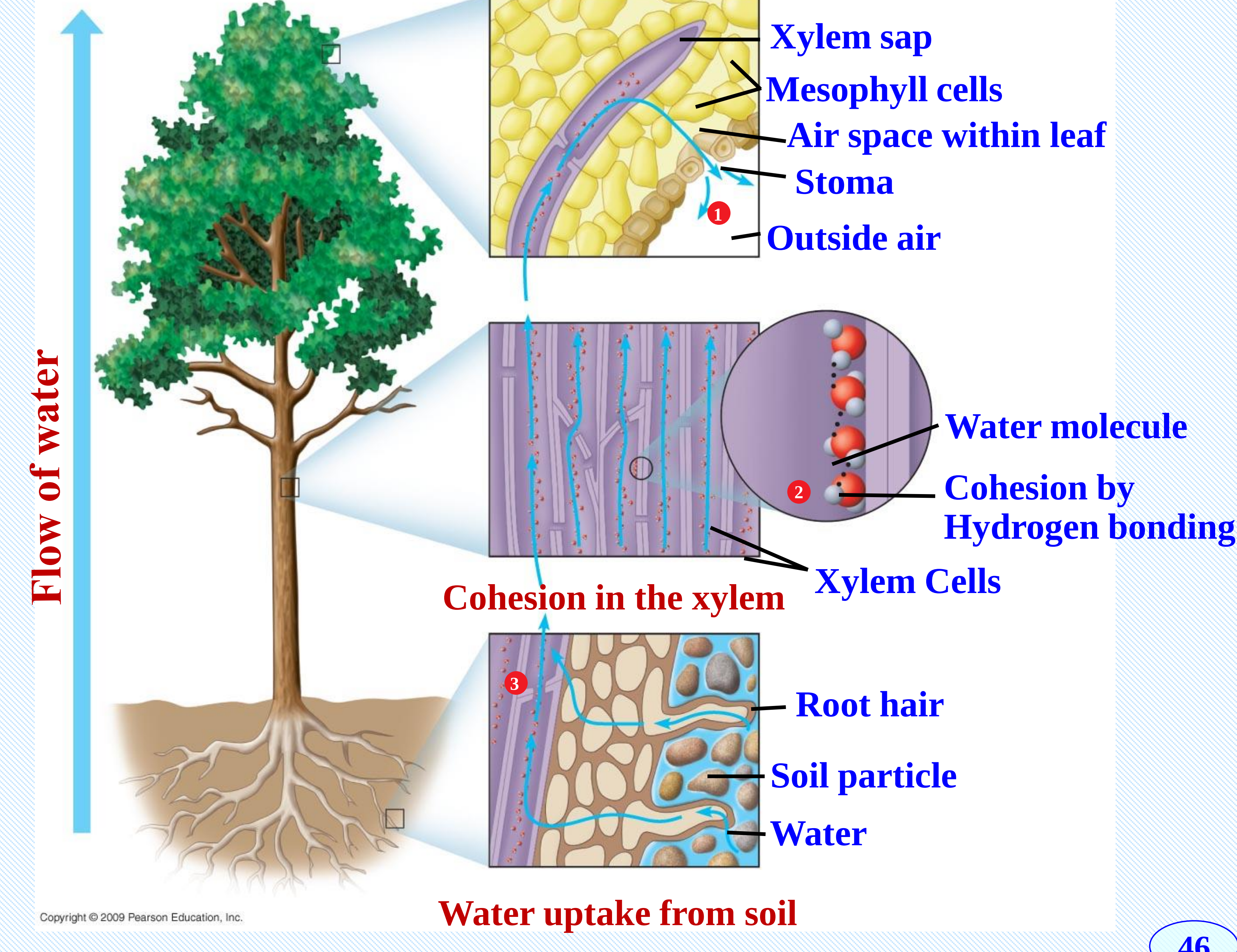
Epidermis
Endodermis
Cortex

Transpiration pulls water up in xylem vessels

- Evaporation of water from the surface of leaves, called transpiration, is the driving force for the movement of xylem sap
- Xylem sap is the solution carried up through a plant in tracheids and vessel elements
- Xylem sap is pulled up through roots and shoots to the leaves
- Water's cohesion and adhesion allow water to be pulled up to the top of the highest trees

Transpiration pulls water up xylem vessels

- Transpiration-cohesion-tension mechanism
  - Water's cohesion describes its ability to stick to itself
  - Water's adhesion describes its ability to stick to other surfaces; water adheres to the inner surface of xylem cells
  - A steep diffusion gradient pulls water molecules from the surface of leaves into much drier air
  - The air's pull on water creates a tension that pulls on water in the xylem; since water is cohesive, it is pulled along, much as when a person sucks on a straw


Xylem sap
Mesophyll cells
Air space within leaf
Stoma
Outside air
1
Flow of water
Water molecule
Cohesion by
Hydrogen bonding
2
Xylem Cells
Cohesion in the xylem
3
Root hair
Soil particle
Water
Water uptake from soil

Guard cells control transpiration

- **Plants must open pores in leaves called stomata to allow CO_2 to enter for photosynthesis**
- **Water evaporates from the surface of leaves through stomata**
- **Paired guard cells surround each stoma**
- **Guard cells can regulate the amount of water lost from leaves by changing shape and closing the stomata pore**

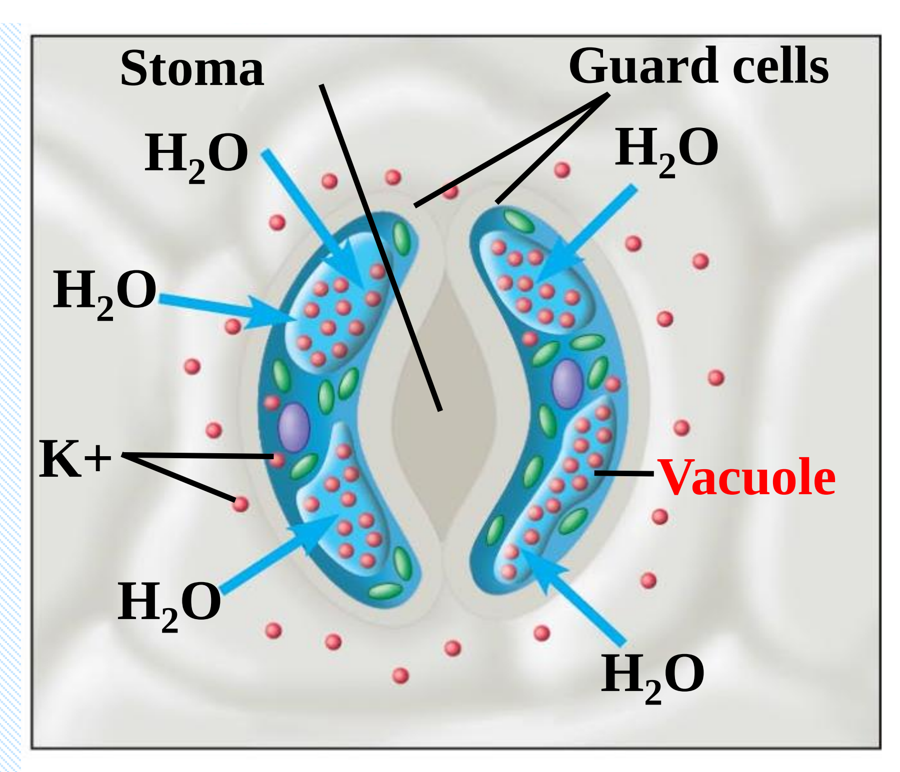
Guard cells control transpiration

- **Stomata open as a result of a rise in potassium levels, and close when the levels fall.**
- **Stomata open when guard cells take up water**
  - **Potassium is actively taken up by guard cells from nearby cells**
  - **This creates an osmotic gradient and water follows**
  - **Uneven cell walls of guard cells causes them to bow when water is taken up**
  - **The bowing of the guard cells causes the pore of the stoma to open**
- **When guard cells lose K^+ ions, the guard cells become flaccid and the stoma closes**

Stoma opening

More K^+ inside guard cell

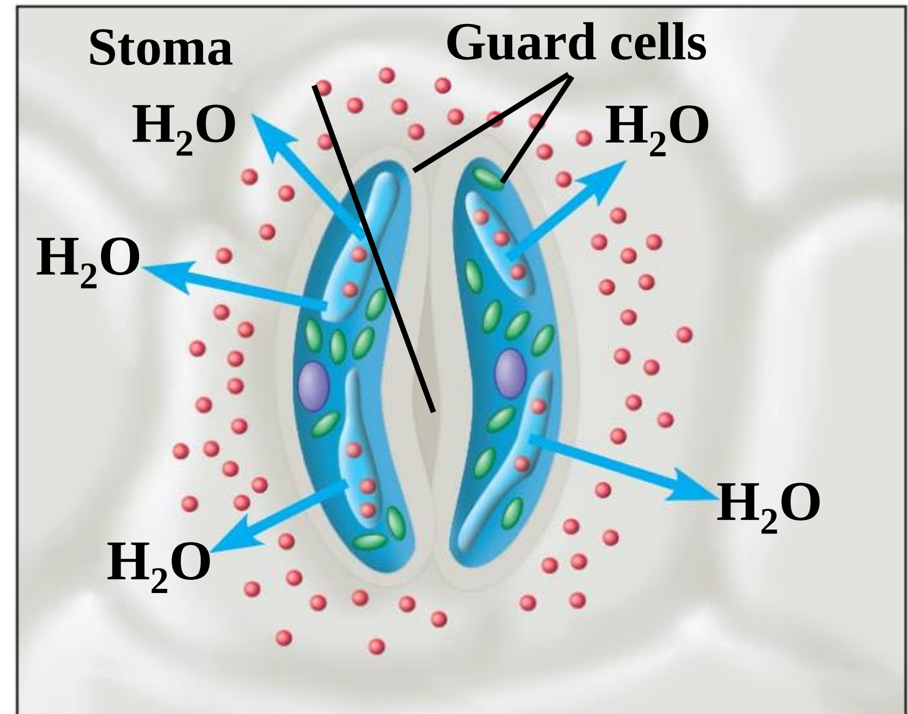
Day time
Low CO_2
Natural Rhythms



Stoma closing



Night time
High CO_2
Natural Rhythms



How guard cells control stomata

Phloem transports sugars

- Phloem transports the products of photosynthesis throughout the plant
  - Phloem is composed of long tubes of sieve tube members stacked end to end
  - Phloem sap moves through sieve plates in sieve tube members
  - Phloem sap is composed of sucrose and other solutes such as ions, amino acids, and hormones
  - Sugars are carried through phloem from sources to sinks

Sugar source and Sugar sink

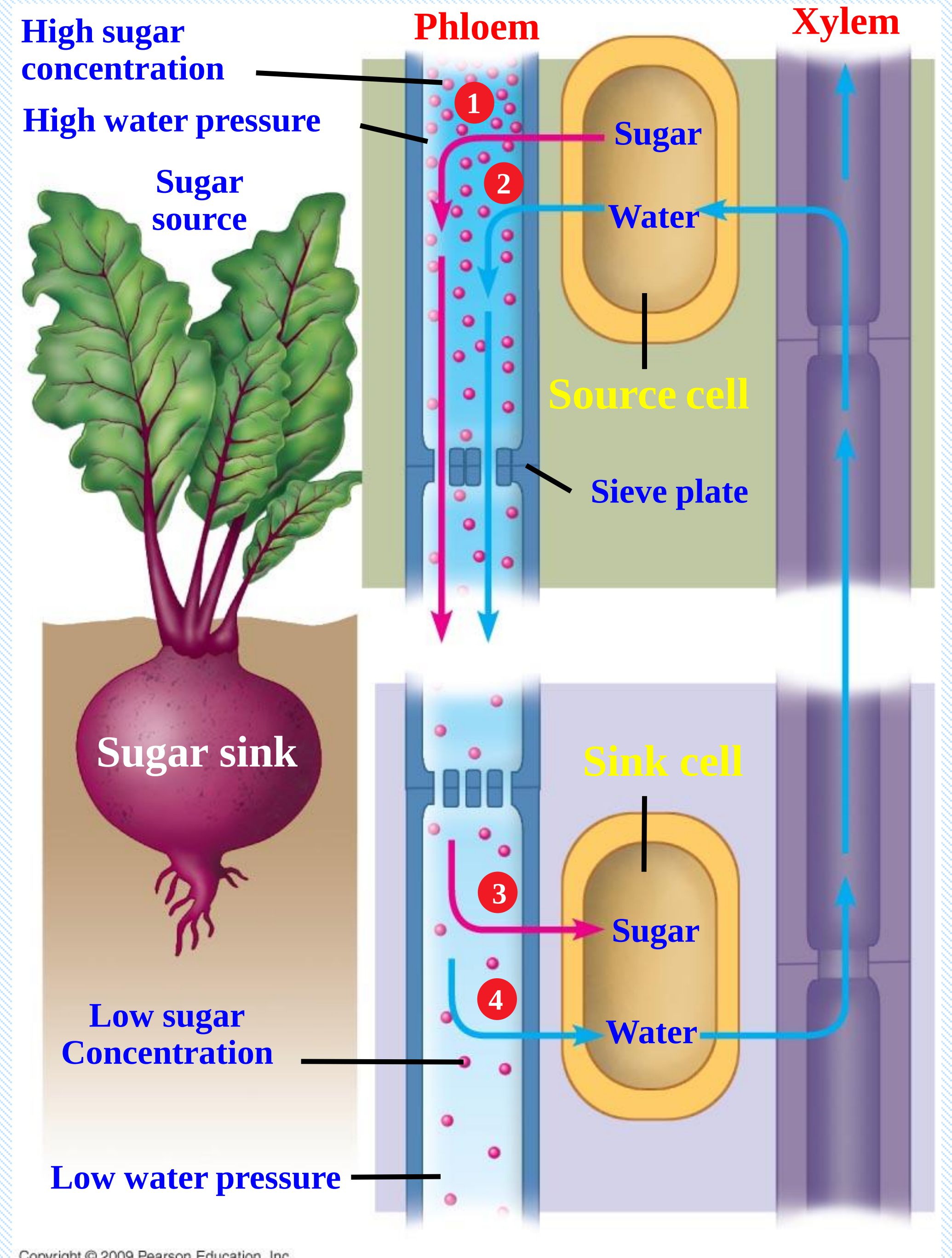
- A sugar source is a plant organ that is a net producer of sugar via photosynthesis or breakdown of starch
  – Leaves produce sugars via photosynthesis
  – Roots and other storage organs produce sugar via breakdown of starch
- A sugar sink is a plant organ that is a net consumer of sugar or one that stores starch
  – Growing organs use sugar in cellular respiration
  – Roots and other organs store unused sugars as starch

The pressure flow mechanism that transports sugars in the Phloem from source to sink

- **The pressure flow mechanism**
  - At sources, sugars are actively loaded into sieve tube members
  - High solute concentration caused by the sugar in sieve tubes causes water to rush in from nearby xylem cells
  - Flow of water into sieve tubes increases pressure at sources
  - At sinks, sugars are unloaded from sieve tubes and solute concentration decreases; water is lost and pressure is low
  - The pressure gradient drives rapid movement of sugars from sources to sinks

Pressure flow in plant phloem from a sugar source to a sugar sink

(and the return of water to the source via xylem)



PLANT NUTRIENTS AND THE SOIL

8-6 Plant health depends on a complete diet of essential inorganic nutrients

- **Essential elements** are those that a plant must obtain to complete its life cycle of growth and reproductive success
- There are 17 elements essential to plant growth and reproduction
  - **Macronutrients** — plants require relatively large amounts of these elements
  - **Micronutrients** — plants require relatively small amounts of these elements
  - Both types of nutrients have vital functions

8-6 Plant health depends on a complete diet of essential inorganic nutrients

- **Macronutrients** — **components of organic molecules**
  - Carbon
  - Hydrogen
  - Oxygen
  - Nitrogen
  - Sulfur
  - Phosphorus
  - Potassium
  - Calcium
  - Magnesium

Make up 98% of plant dry weight

8.6 Plant health depends on a complete diet of essential inorganic nutrients

- **Micronutrients — often act as cofactors**
  - Chlorine
  - Iron
  - Manganese
  - Boron
  - Zinc
  - Copper
  - Nickel
  - Molybdenum

Micronutrients

Fertile soil supports plant growth

- Soils are affected by geography and climate
- Soil horizons are layers of soil with different characteristics
  - A horizon — topsoil subject to weathering; layer contains humus (decayed organic matter) and many soil organisms
  - B horizon — clay and dissolved elements
  - C horizon — rocks of the "parent material" from which soil is formed



Three soil horizons visible beneath grass

PLANT NUTRITION AND SYMBIOSIS WITH BACTERIA

Most plants depend on bacteria to supply nitrogen

- **Most of the nitrogen in the biosphere is in the atmosphere as N_2 gas**
- **Plants can only absorb nitrogen as ammonium or nitrates from the soil; they cannot absorb it from air**

Most plants depend on bacteria to supply nitrogen

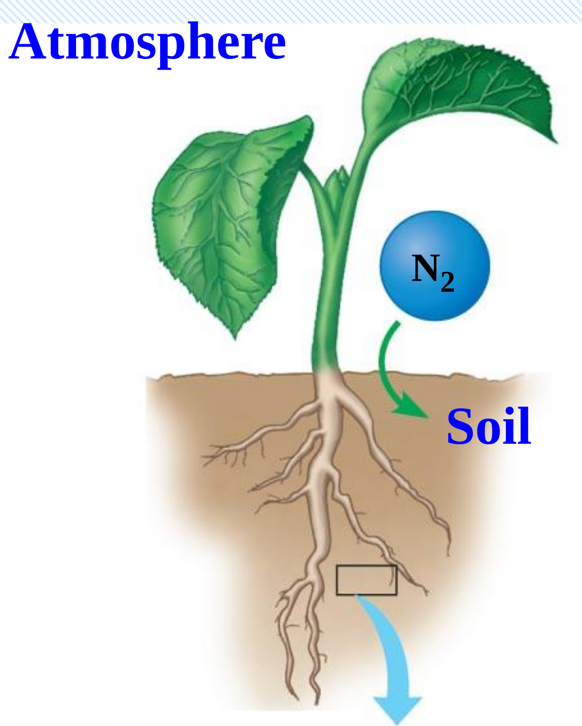
- **Soil bacteria can convert N_2 gas from the air into forms usable by plants via several processes**

1) **Nitrogen fixation — N_2 is converted to ammonia**

2) **Ammonification — conversion of organic matter into ammonium**

3) **Nitrification — conversion of ammonium to nitrates, the form most often taken up by plants**

The roles of bacteria in supplying nitrogen to plants



N_2

Nitrogen-fixing Bacteria

H^+

NH_3

NH_4^+ (ammonium)

Nitrifying Bacteria

NO_3^- (nitrate)

NH_4^+

Amino acids, etc.

Root

Organic material

Ammonifying Bacteria

The plant kingdom includes epiphytes, parasites and carnivores

1. Epiphytes

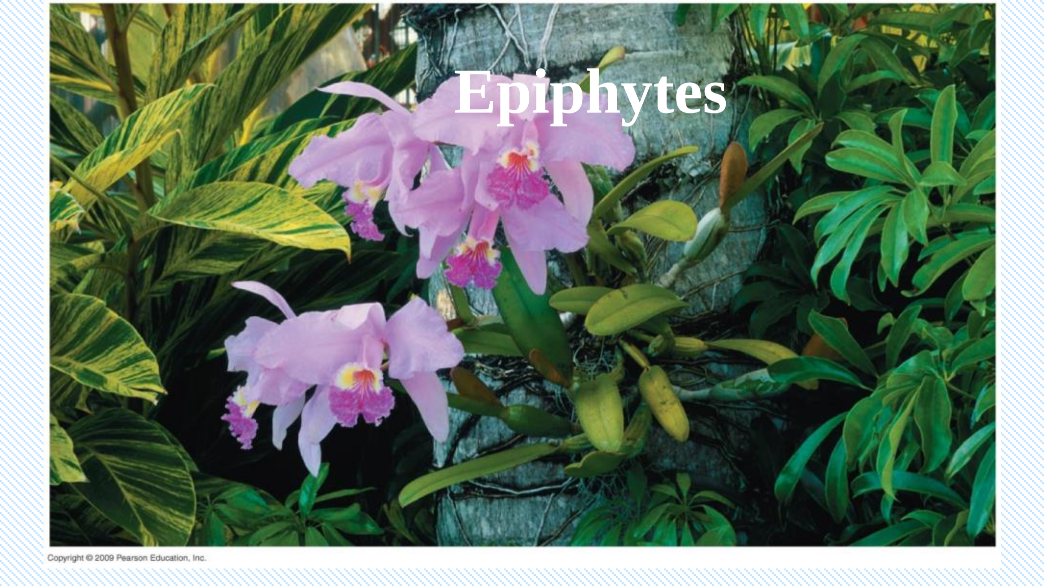
- Grow anchored on other plants
- Absorb water and minerals from rain

2. Parasites

- Roots tap into the host plant's vascular system
- Incapable of photosynthesis
- Absorb organic molecules from host plant

3. Carnivores

- Trap and digest small animals such as insects
- Absorb inorganic elements from prey
- Found in nutrient poor environments



Orchids, a type of epiphyte, growing on the trunk of a tree



Dodder growing on a pickle weed



A Venus' flytrap digesting a fly

Chapter 9

GAS EXCHANGE & CIRCULATION

MECHANISMS OF GAS EXCHANGE

Respiration

Taking up O_2 and giving up CO_2

MECHANISMS OF GAS EXCHANGE

- **Three phases of gas exchange**
  - **Breathing**
  - **Transport of oxygen and carbon dioxide in blood**
  - **Body tissues take up oxygen and release carbon dioxide in the process of Cellular respiration**
- **Cellular respiration (Glucose + $O_2 \rightarrow CO_2 + H_2O$) requires a continuous supply of oxygen and the disposal of carbon dioxide**

Animals exchange O_2 and CO_2 across respiratory surfaces

Respiratory Surface = the site of gas exchange

- **Respiratory surfaces must be thin and moist for diffusion of O_2 and CO_2**
- **Earthworms and other animals use their skin for gas exchange**
- **Most animals have specialized body parts that promote gas exchange called Respiratory Surface = the site of gas exchange include:**

  1) **Skin** Sponges, jellies and flatworms rely on the skin as their only respiratory surface
  2) **Gills** in fish and amphibians
  3) **Tracheal systems** in arthropods
  4) **Lungs** in tetrapods that live on land, amphibians, reptiles, birds and mammals

Lungs

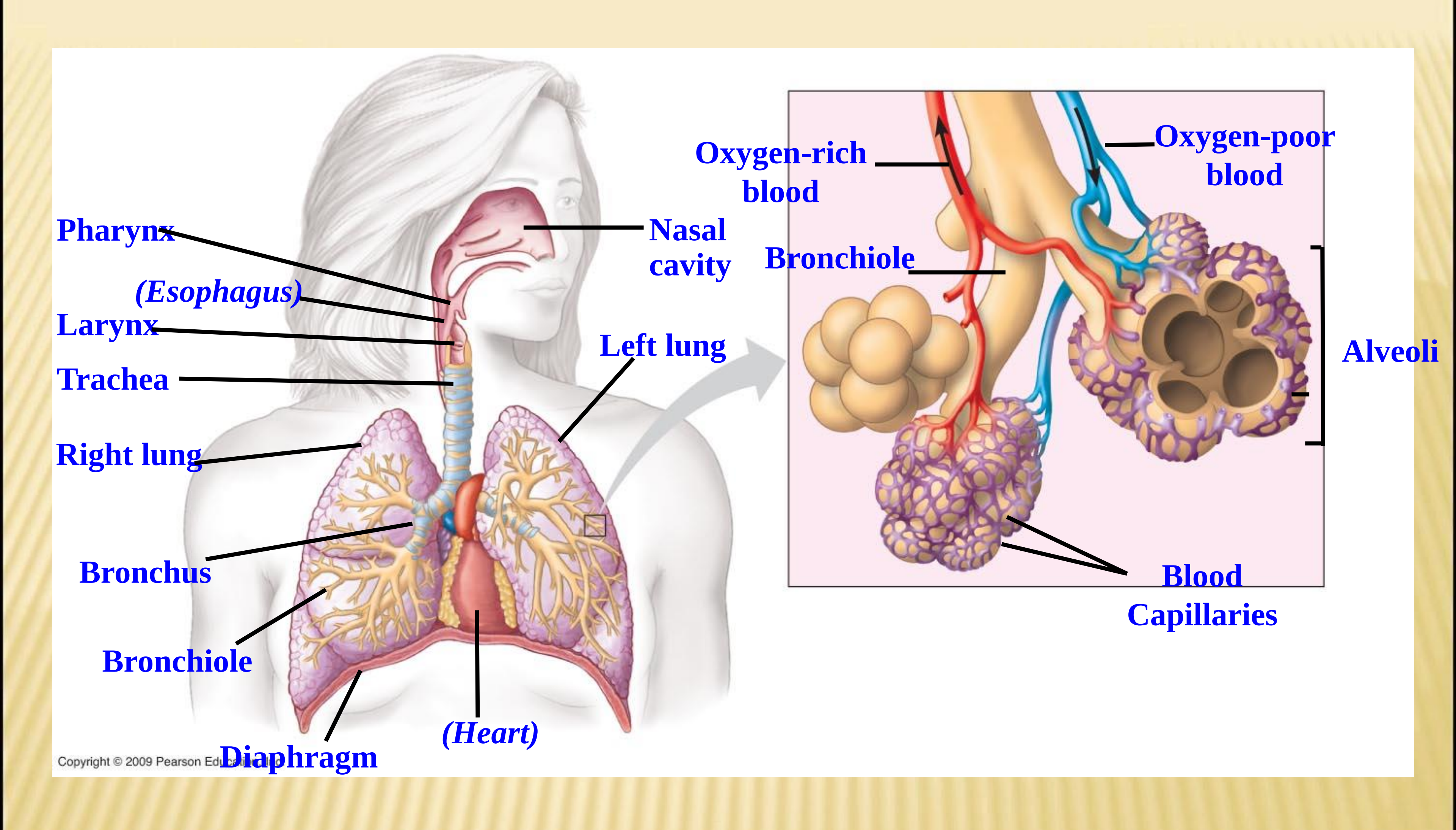
- **Tetrapods seem to have evolved in shallow water**
- **The first tetrapods on land diverged into three major lineages**
  - **Amphibians use small lungs and their body surfaces**
  - **Nonbird reptiles have lower metabolic rates and simpler lungs**
  - **Birds and mammals have higher metabolic rates and more complex lungs**

In the human respiratory system, branching tubes convey air to lungs located in the chest cavity

- **In mammals, air is inhaled through the nostrils into the nasal cavity**
  - **Air is filtered by hairs and mucus surfaces**
  - **Air is warmed and moisturized**
  - **Air is sampled for odors**

In the human respiratory system, branching tubes convey air to lungs located in the chest cavity

- From the nasal cavity, air next passes
  - To the pharynx
  - Then larynx, past the vocal cords
  - Into the trachea (held open by cartilage crescent rings)
  - Into the paired bronchi
  - Into bronchioles
  - Bronchioles ends in a cluster of “bubbles” – the alveoli, grapelike clusters of air sacs, where gas exchange occurs



The anatomy of the human respiratory system (left) and details of the structure of alveoli (right)

How alveoli are adapted for gas exchange ?

- **Alveoli are well adapted for gas exchange**
  - **Alveoli are surrounded by capillaries**
  - **This is the actual site of gas exchange**
  - **Huge surface area (100 m^2 in humans)**
- **In alveoli**
  - **O_2 diffuses into the blood**
  - **CO_2 diffuses out of the blood**

Mechanics of Breathing

Breathing is the alternate inhalation and exhalation of air (ventilation)

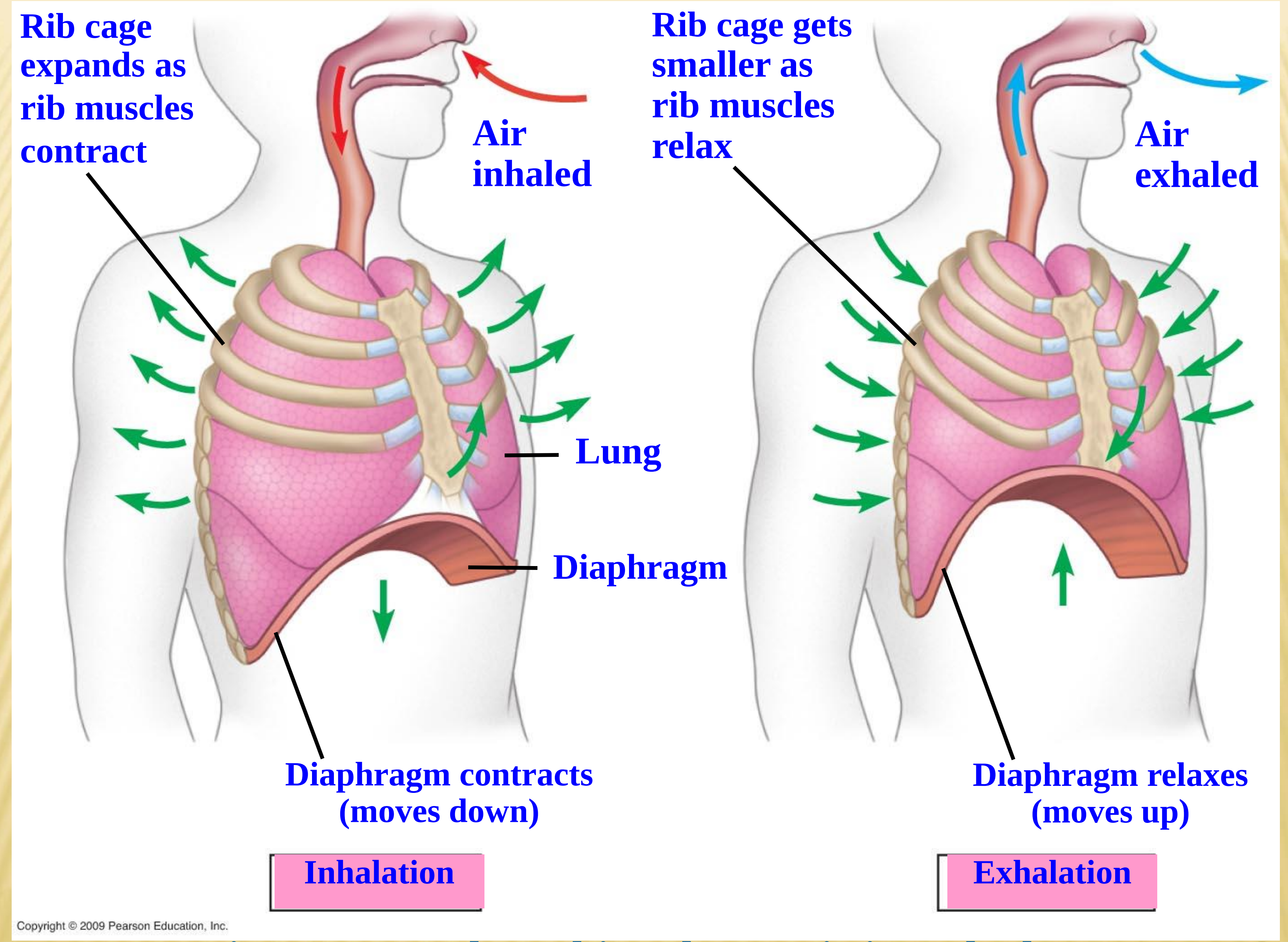
1) Inhalation occurs when

- **The rib cage expands (muscles between ribs contract and rib cage rises)**
- **The diaphragm moves downward**
- **The volume of the chest cavity increases, lowering the air pressure around lungs.**
- **Air rushes into lungs to equalize the pressure difference**
-

22.8 Negative pressure breathing ventilates our lungs

2) Exhalation occurs when

- **The rib cage contracts**
- **The diaphragm moves upward**
- **The pressure around the lungs increases**
- **And air is forced out of the respiratory tract**



Negative pressure breathing draws air into the lungs

Breathing is automatically controlled

- Breathing is usually under automatic control.
- It is controlled by two centers at the base of the brain the pons and medulla oblongata
- Breathing control centers in the brain sense and respond to CO_2 levels in the blood
- A decrease in blood pH increases the rate and depth of breathing

$$CO_2 + H_2O \rightleftharpoons H_2CO_3 \rightleftharpoons H^+ + HCO_3^-$$

Carbon Dioxide — Water — Carbonic Acid — Hydrogen Ions — Bicarbonate

- Aorta and carotid arteries have O_2 sensors which signal the brain to increase breathing

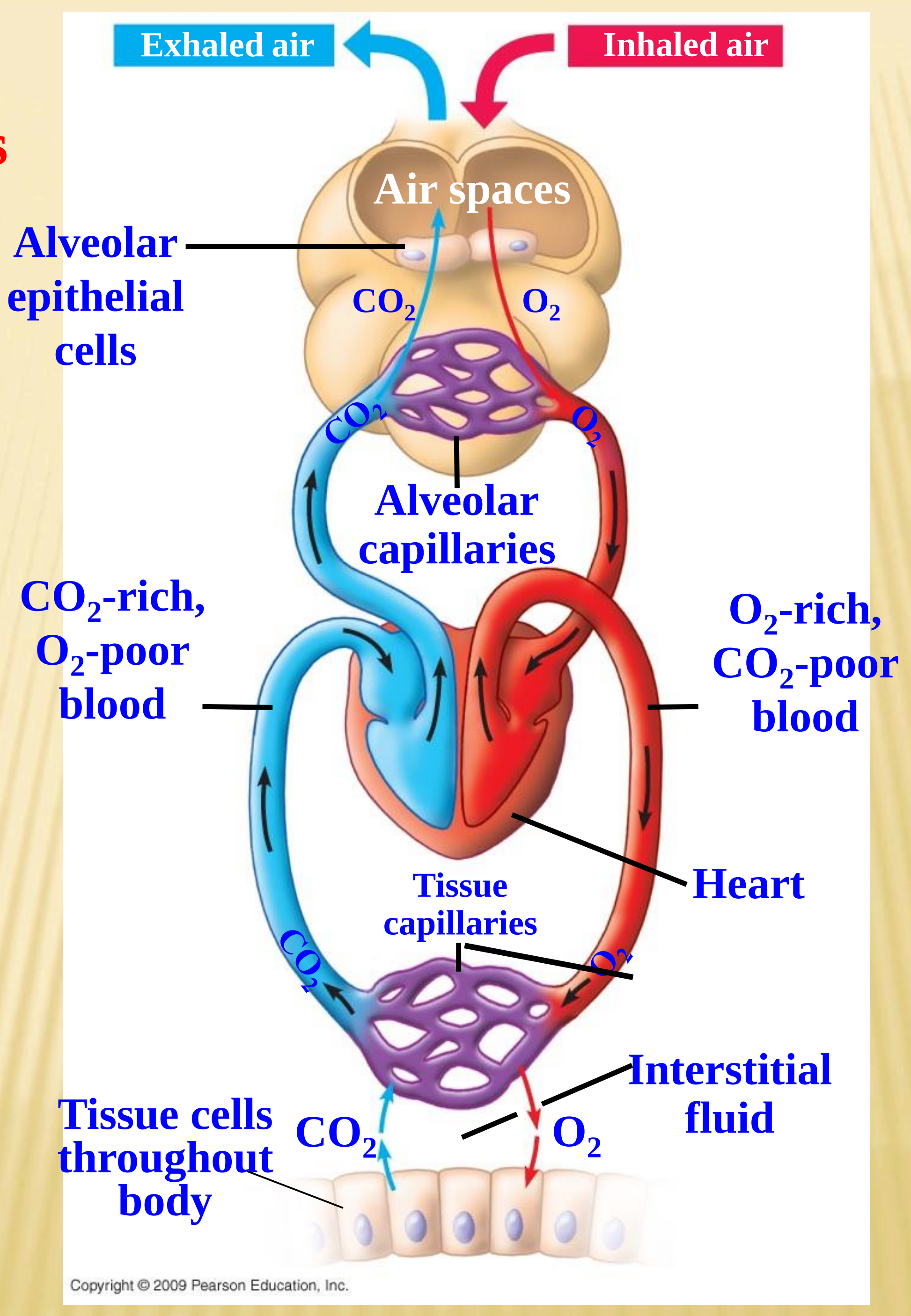
TRANSPORT OF GASES IN THE HUMAN BODY

Blood transports of respiratory gases

- **In the lungs, blood picks up O_2 and drops off CO_2**
- **In the body tissues, blood drops off O_2 and picks up CO_2**

- **The heart pumps blood to two regions**
  - **The right side pumps oxygen-poor blood to the lungs**
  - **The left side pumps oxygen-rich blood to the body**

Coordination of circulation and gas exchange



Gas transport and exchange in the body.

Blood transport of gases

- Gases move from areas of higher concentration to areas of lower concentration

Gases exchange between alveoli and blood

– Gases in the alveoli have more O_2 and less CO_2 than gases the blood

– O_2 moves from the alveoli of the lungs into the blood

– CO_2 moves from the blood into the alveoli of the lungs

Gases exchange between blood and tissues

– The tissues have more CO2 and less O2 than in the blood

– CO2 moves from the tissues into the blood

– O2 moves from the blood into the tissues

Blood transport of gases

1. Once the oxygen reaches the body cells, it is taken up by the mitochondria.

2. The mitochondria use oxygen to breakdown glucose into ATP. This is called cellular respiration

Oxygen transport

- Oxygen is not very soluble in water (blood)
- Oxygen transport and delivery are enhanced by binding of O_2 to respiratory pigments (hemoglobin in vertebrates)
- Binding is reversible

Respiratory pigments

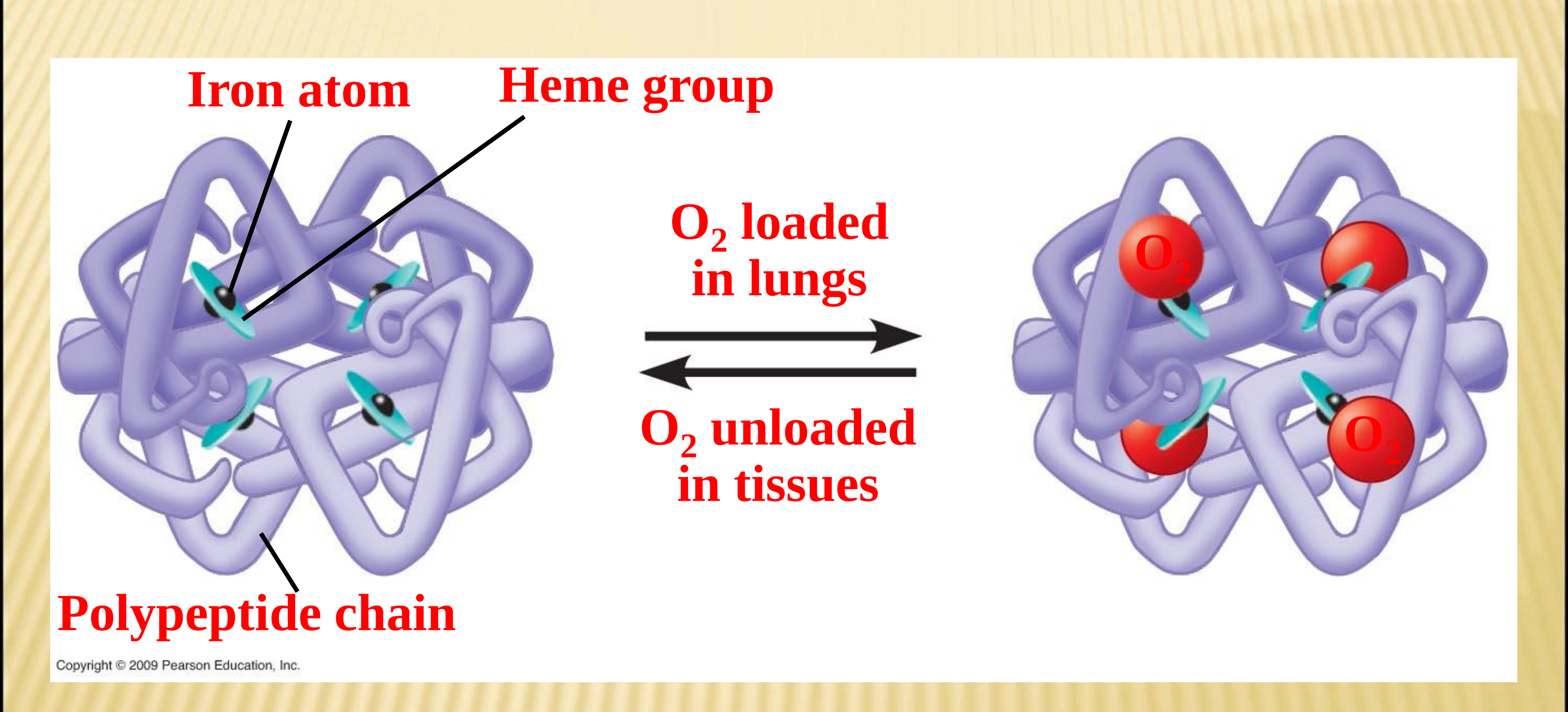
- **Most animals transport O_2 bound to proteins called respiratory pigments**

1) Copper-containing pigment (hemocyanin)

in Mollusca and Arthropods

2) Iron-containing pigment (hemoglobin)

in almost all vertebrates and many invertebrates transports oxygen, buffers blood, and transports CO_2



Hemoglobin loading and unloading of O_2

Carbon dioxide transport

- **Most CO_2 in the blood is transported as bicarbonate ions in the plasma**

$$CO_2 + H_2O \rightleftarrows H_2CO_3 \rightleftarrows H^+ + HCO_3^-$$

Carbon Dioxide | Water | Carbonic Acid | Hydrogen Ions | Bicarbonate

Circulation

3 Major Parts of the Circulatory system

- **Circulatory system in most animals consists of Blood, Heart and Blood vessels**
- **Blood Vessels - networks of hollow tubes that transport blood throughout the entire body.**
- **Heart – pumps blood through body**
- **Blood – carries oxygen, food, & waste ..etc through body.**

MECHANISMS OF INTERNAL TRANSPORT

- **An internal transport system assists diffusion by moving materials between**
  - **Surfaces of the body**
  - **Internal tissues**

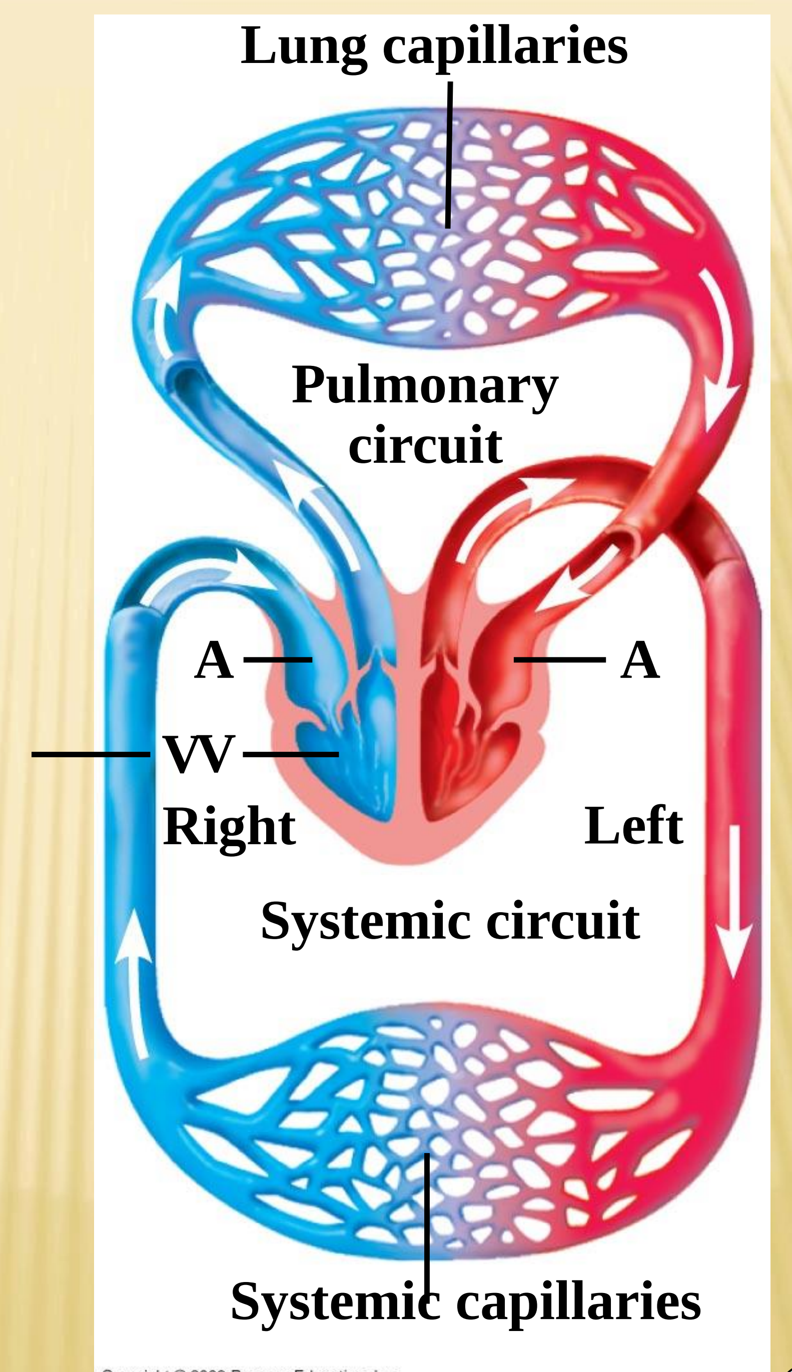
Circulatory systems facilitate exchange with all body tissues

- **All cells need**
  - **Nutrients**
  - **Gas exchange**
  - **Removal of wastes**

Four-chambered hearts: Two atria and two ventricles

- **Four-chambered hearts Two atria and two ventricles**
  - **Two circuits that do not mix**
    - **Right side pumps blood from body to lungs**
    - **Left side pumps blood from lungs to body**
- **Oxygen rich blood is completely separated from oxygen poor blood**
- **No mixing → much more efficient gas transport**
- **Birds, mammals Crocodilians have four-chambered hearts**
- **Needed in endothermic animals**

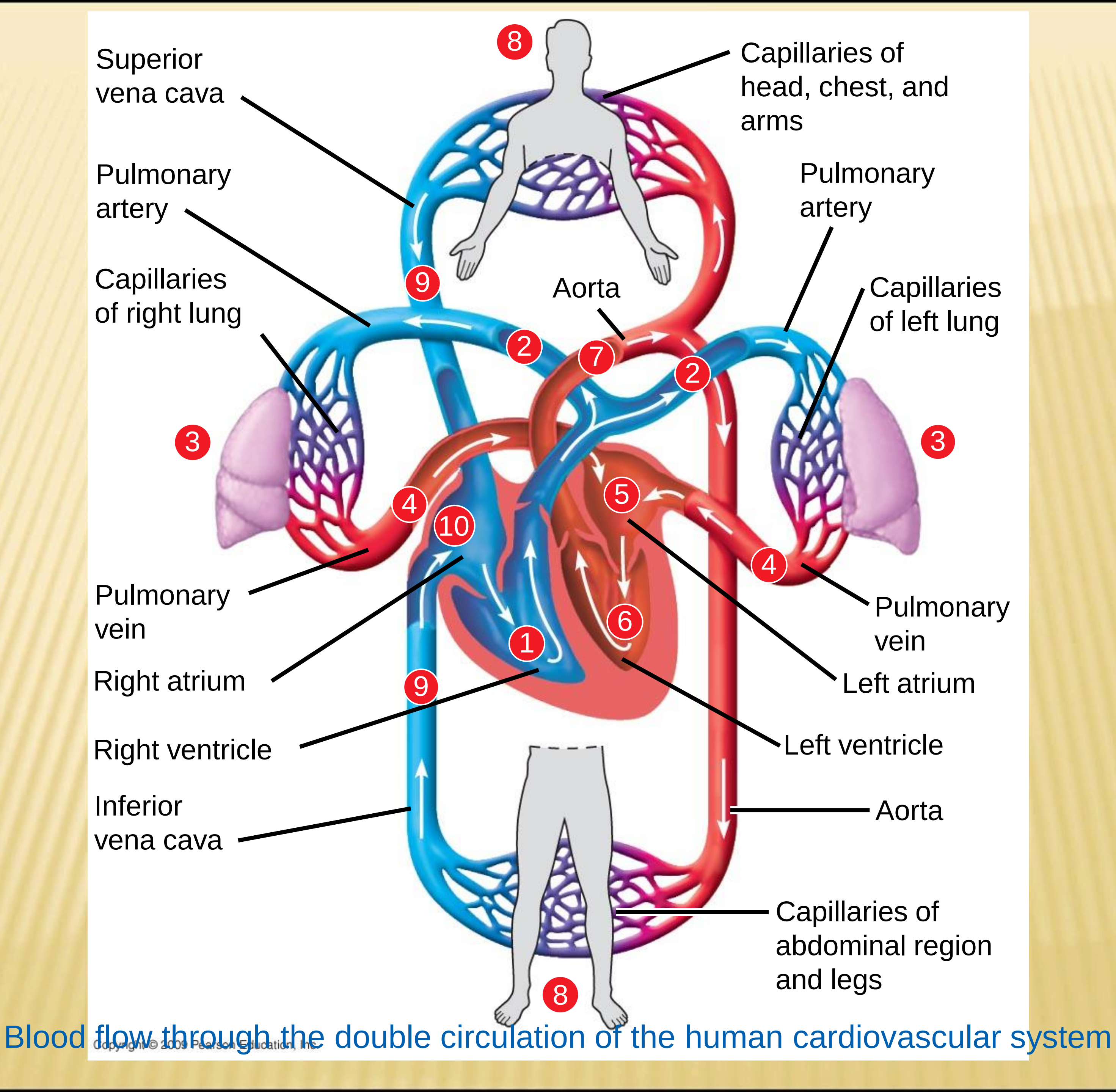
The double circulation and four-chambered heart of a bird or mammal



THE HUMAN CARDIOVASCULAR SYSTEM

The human cardiovascular system illustrates the double circulation of mammals

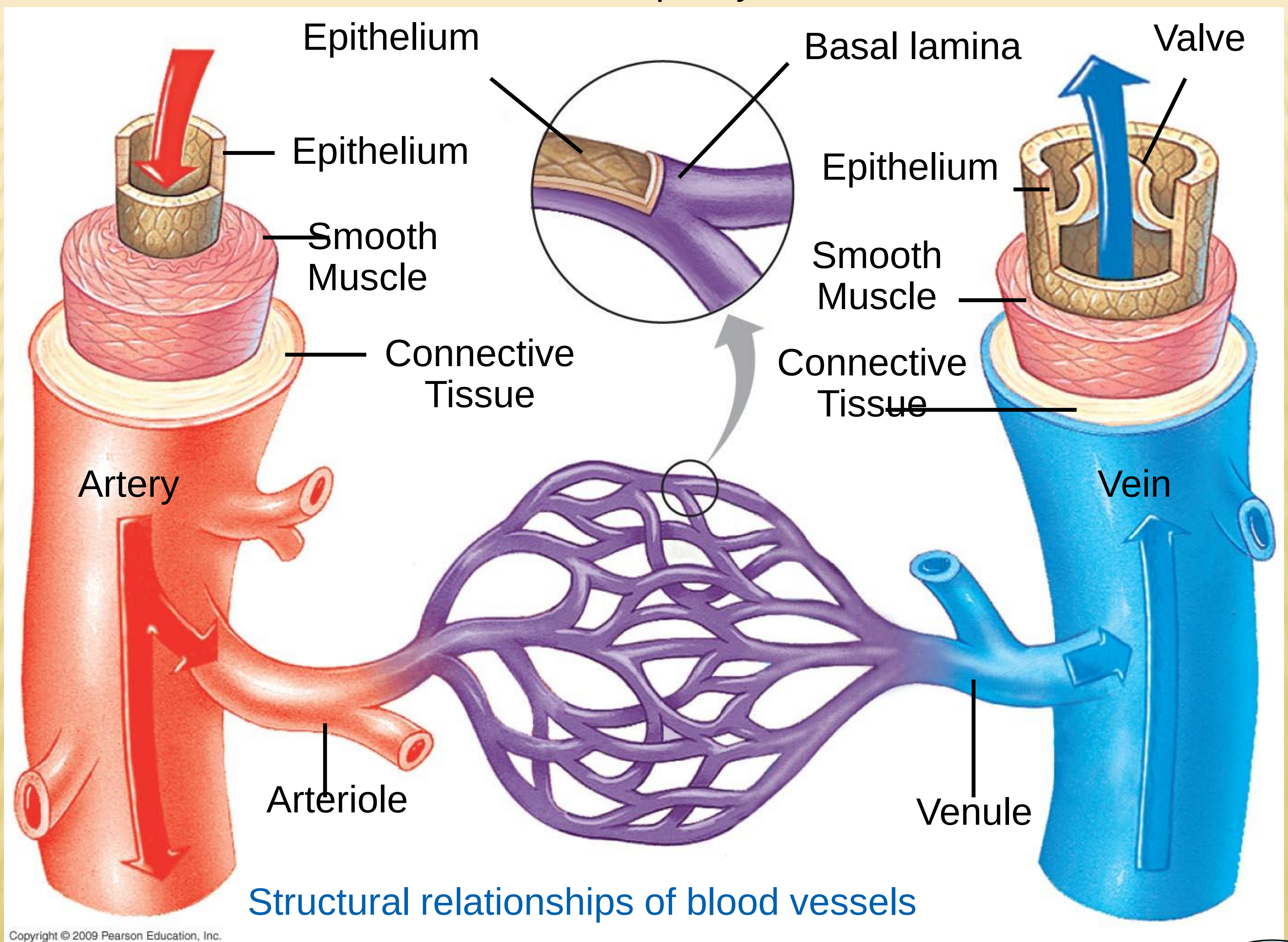
- **Blood flow through the double circulatory system of humans**
- **The mammalian heart consists of**
  - **Two thin-walled atria that move blood to ventricles**
  - **Thick-walled ventricles that Pump blood to lungs and all other body regions**



Blood flow through the double circulation of the human cardiovascular system

The structure of blood vessels fits their functions

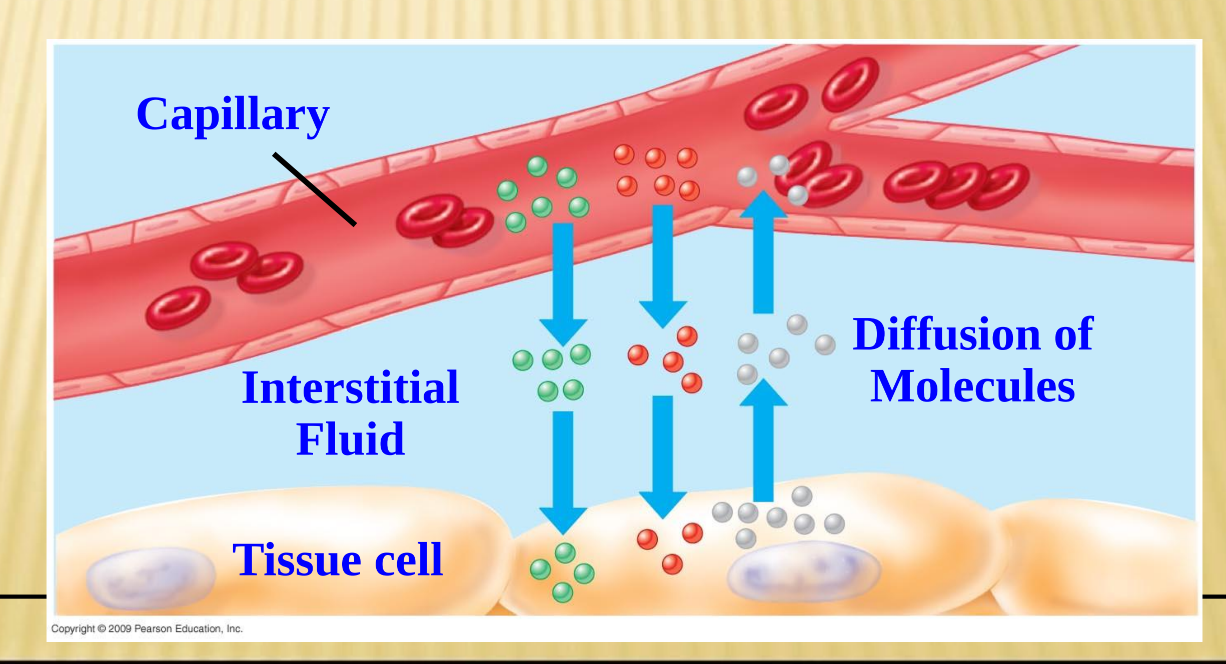
- Arteries and veins
  - Arteries have thicker walls than veins
  - Arteries are under more pressure than veins
  - Veins have one-way valves that restrict backward flow and force blood back to right heart atrium


Capillary
Epithelium
Basal lamina
Valve
Epithelium
Smooth Muscle
Connective Tissue
Epithelium
Smooth Muscle
Connective Tissue
Artery
Vein
Arteriole
Venule
Structural relationships of blood vessels

Capillaries are the exchange surface

- Capillaries
  - Thin walls: a single layer of epithelial cells
  - Narrow: blood cells flow in a single file
  - Increase surface area for gas and fluid exchange
  - Gas exchange and other transfers occur in the capillary beds
  - Endocytosis → exocytosis across membrane. Diffusion based on electrochemical gradients

Diffusion between blood and tissue cells



The heart contracts and relaxes rhythmically

- **Cardiac output**: **Amount of blood/minute pumped into systemic circuit**
- **Heart rate**: **Number of beats/minute**
- **Heart valves**: **Prevent the backflow of blood**
- **Heart murmur**: **A defect in one or more heart valves**

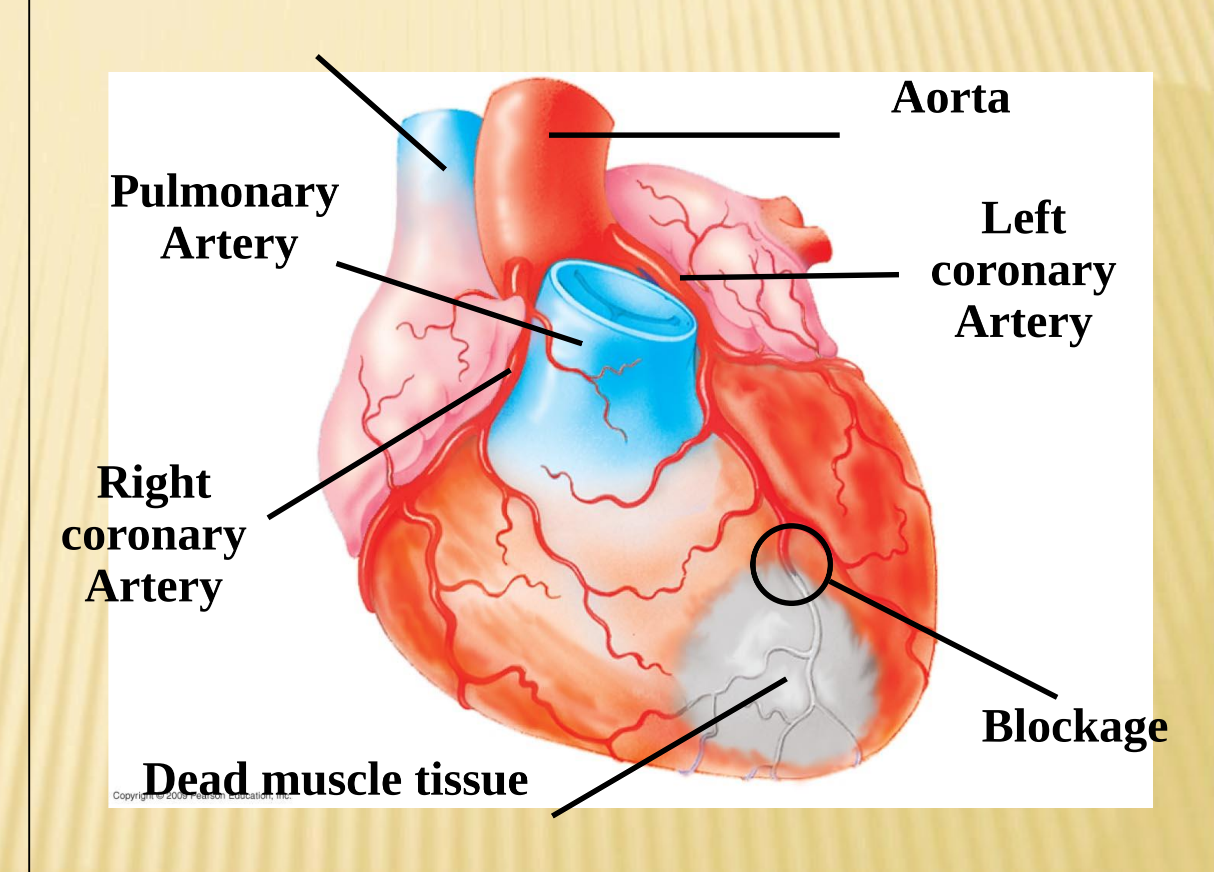
The pacemaker sets the tempo of the heartbeat

- **The pacemaker (SA node)**
  - **Sets the rate of heart contractions**
  - **Generates electrical signals in atria**

- **The AV node**
  - **Relays these signals to the ventricles**

CONNECTION: What is a heart attack

- **A heart attack is damage to cardiac muscle typically from a blocked coronary artery**
- **Stroke Death of brain tissue from blocked arteries in the head**

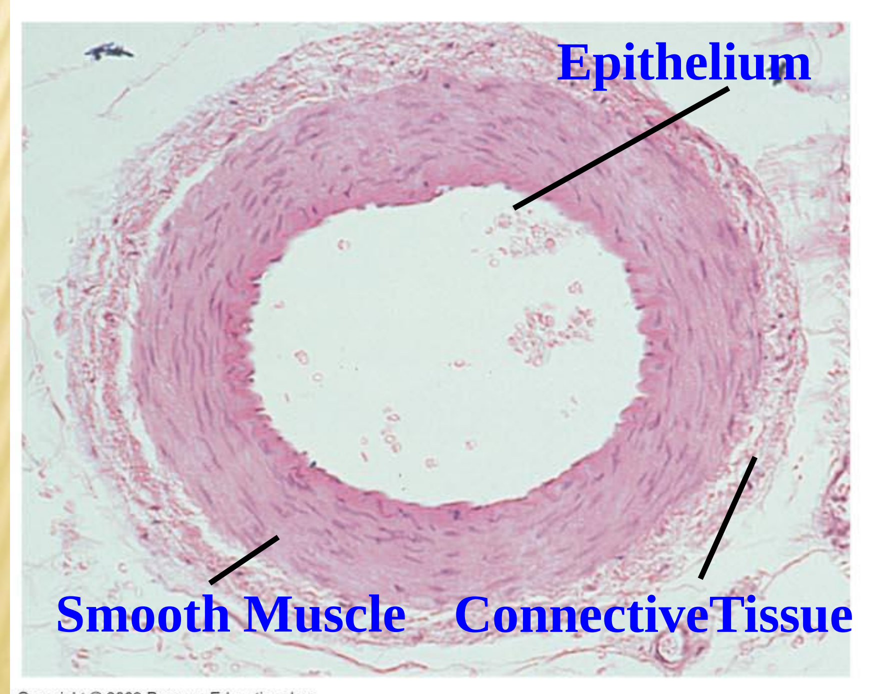


Blockage of a coronary artery, resulting in a heart attack

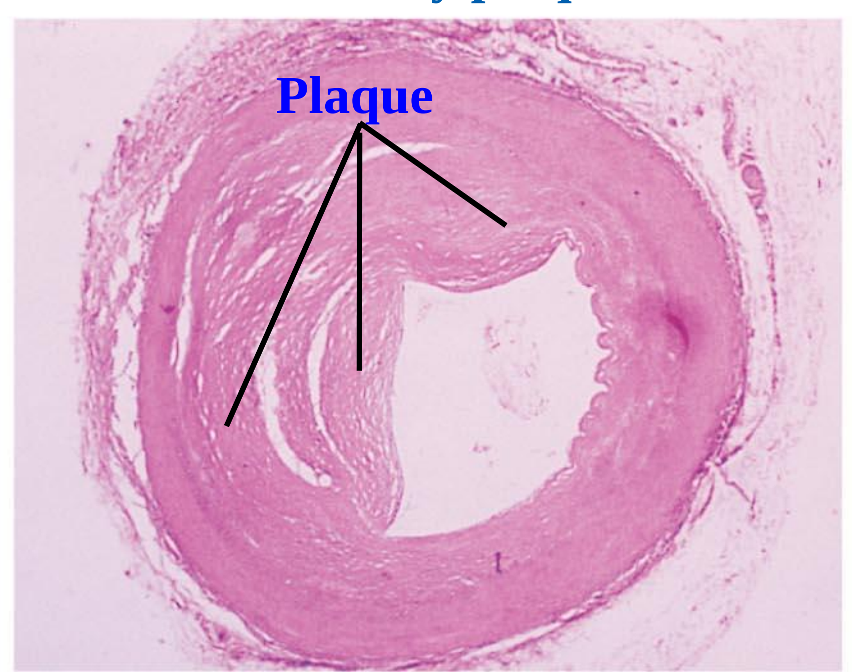
CONNECTION: What is a heart attack?

- Atherosclerosis
  - Plaques develop inside inner walls of blood vessels
  - Plaques narrow blood vessels
  - Blood flow is reduced

A normal artery



Atherosclerosis: an artery partially closed by plaque



Blood pressure and velocity reflect the structure and arrangement of blood vessels

- **Blood pressure: The force blood exerts on vessel walls**
  - **Depends on cardiac output and resistance of vessels**
  - **Decreases as blood moves away from heart**
  - **Highest in arteries & lowest in veins**
  - **It is measured as**
    - **Systolic pressure: caused by ventricular contraction**
    - **Diastolic pressure: low pressure between contractions**

BLOOD STRUCTURE AND FUNCTION

- **Blood consists of:**

1. **Cellular elements (red and white blood cells and platelets) suspended in plasma.**
2. **Plasma which is about 90% water and contains**
   - **Various inorganic ions**
   - **Proteins, nutrients**
   - **Wastes, gases**
   - **Hormones**

Blood Cellular Elements

1) **Red blood cells (erythrocytes)**

   Transport O_2 bound to hemoglobin

2) **White blood cells (leukocytes)**

   Function inside and outside the circulatory system

   Fight infections and cancer

3) **Platelets: Small fragments of cells promote clotting**

Centrifuged blood Sample

Cellular elements (45%)		
Cell type	Number العدد per µL (mm^3) of blood	Functions
Erythrocytes (red blood cells)	5–6 million	Transport of oxygen (and carbon dioxide)
Leukocytes (white blood cells)	5,000–10,000	Defense and Immunity
Basophil, Eosinophil, Lymphocyte, Neutrophil, Monocyte		
Platelets	250,000–400,000	Blood clotting



CONNECTION: Too few or too many red blood cells can be unhealthy

- **Anemia**
  - **Abnormally low amounts of hemoglobin or red blood cells**
  - **Causes fatigue due to lack of oxygen in tissues**
- **Erythropoietin hormone (EPO) Regulates red blood cell production**
- **Some athletes artificially increase red blood cell production by injecting erythropoietin which can lead to Clotting , Stroke, Heart failure, Death**

The Clotting Process

Blood clots plug leaks when blood vessels are injured

- **When a blood vessel is damaged**
  - **Platelets help trigger the conversion of fibrinogen (plasma protein) → fibrin (fiber) which makes knit that forms a clot and plugs the leak**
- **The blood-clotting process**
  - **Platelets adhere to exposed connective tissue**
  - **Platelets form a plug**
  - **A fibrin clot traps blood cells**

1 Platelets adhere to exposed connective tissue

2 Platelet plug Forms

3 Fibrin clot traps blood cells

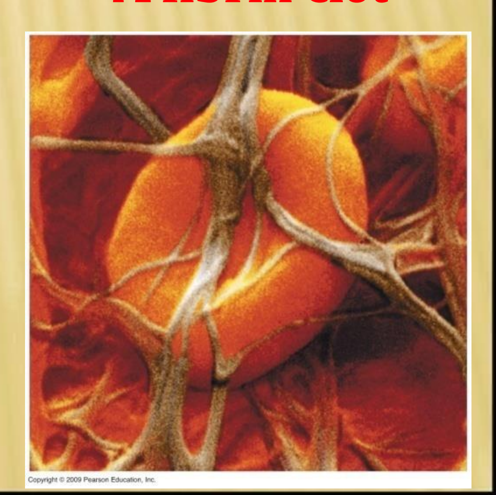
Epithelium

Connective Tissue

Platelet

Platelet plug

A fibrin clot



The blood-clotting process

Chapter 10

EXCRETION

Control of Body Temperature and Water Balance

Control of Body Temperature and Water Balance as a part of homeostasis

- **Homeostasis means**
  - **Maintenance of steady internal conditions despite fluctuations in the external environment**
- **Examples of homeostasis**
  - **Thermoregulation:** **the maintenance of internal temperature within narrow limits**
  - **Osmoregulation:** **the control of the gain and loss of water and solutes**
  - **Excretion:** **the disposal of nitrogen-containing wastes**

Thermoregulation: An animal's regulation of body temperature helps maintain homeostasis

Thermoregulation

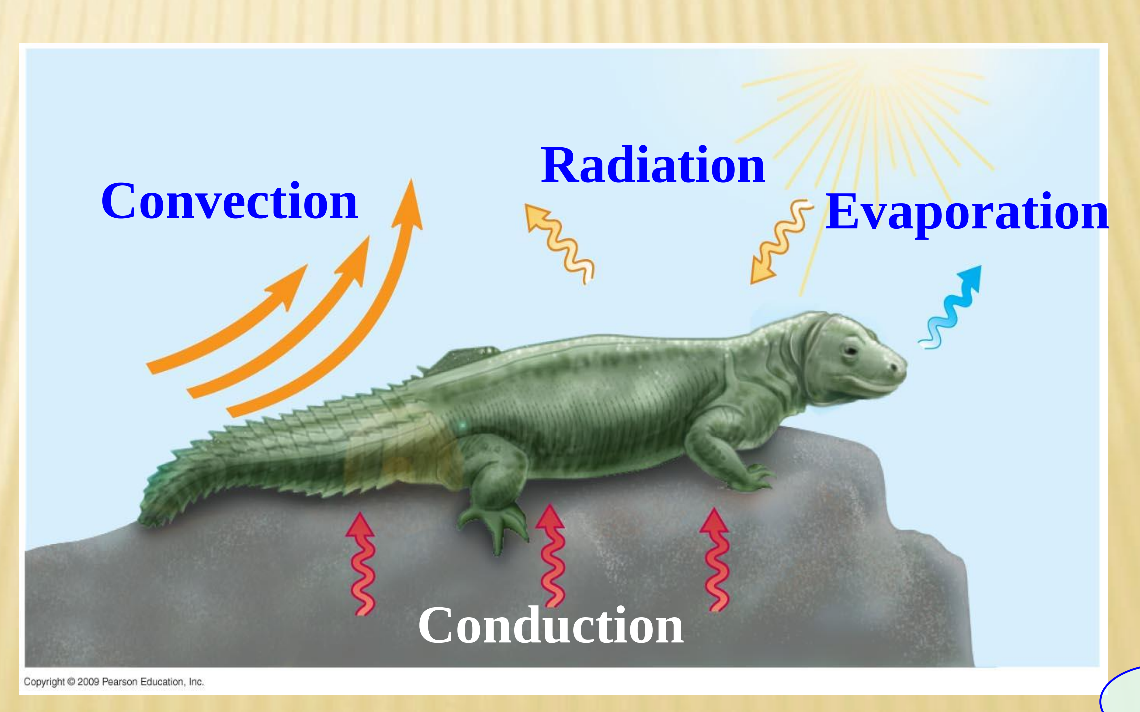
- The process by which animals maintain an internal temperature within a tolerable range

- **Ectothermic** animals
  - Absorb heat from their surroundings
  - Many fish, most amphibians, lizards, most invertebrates
- **Endothermic** animals
  - Derive body heat mainly from their metabolism
  - Birds, mammals, a few reptiles and fish, many insects

Heat is gained or lost in four ways

- Heat exchange with the environment may occur by
  1. Conduction
  2. Convection
  3. Radiation
  4. Evaporation

Mechanisms of heat exchange



Adaptations that balance heat gain and loss

- **Five general categories of adaptations promote thermoregulation**

1- Increased metabolic heat production

  - **Hormonal changes boost metabolic rate in birds and mammals**
  - **Shivering**
  - **Increased physical activity**
  - **Honeybees cluster and shiver**

Thermoregulation involves adaptations that balance heat gain and loss

2- Insulation

- Hair
- Feathers
- Fat layers



3- Circulatory adaptations

- Increased or decreased blood flow to skin by changing diameter of skin blood vessels
- Large ears in elephants
- Countercurrent heat exchange

Thermoregulation involves adaptations that balance heat gain and loss

4- <u>Evaporative cooling</u>

- **Sweating**
- **Panting**

5- <u>Behavioral responses</u>

- **Used by endotherms and ectotherms**
- **Examples:**
  - **Moving to the sun or shade**
  - **Migrating**
  - **Bathing**

Osmoregulation and Excretion

Osmoregulation is the active regulation of the osmotic pressure of an organism’s fluids to maintain the homeostasis of the organism's water content; that is, it keeps the organism's fluids from becoming too diluted or too concentrated.

Animals balance the gain and loss of water and solutes through osmoregulation

- **Osmoconformers**
  - **Have the same internal solute concentration as sea water**
  - **Many marine invertebrates are osmoconformers**

- **Osmoregulators control their solute concentrations**
  - **Freshwater fishes**
    - **Gain water by osmosis**
    - **Excrete excess water**
    - **Uptake salt across their gills**

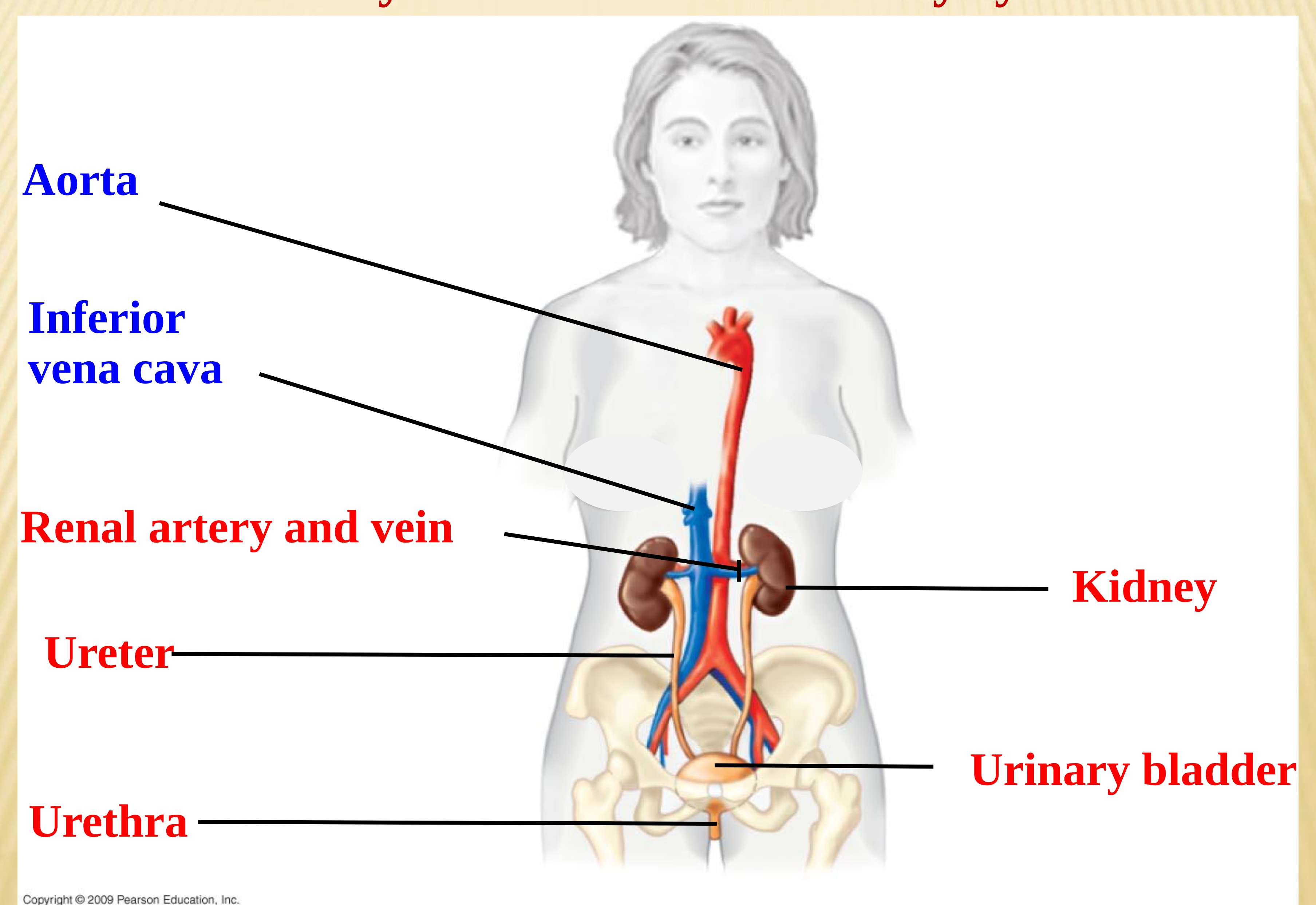
EXCRETION

- **Excretion is the process by which waste products of metabolism and other non-useful materials are eliminated from an organism.**
- **In vertebrates this is primarily carried out by the kidneys and skin**

The Mammalian Excretory System

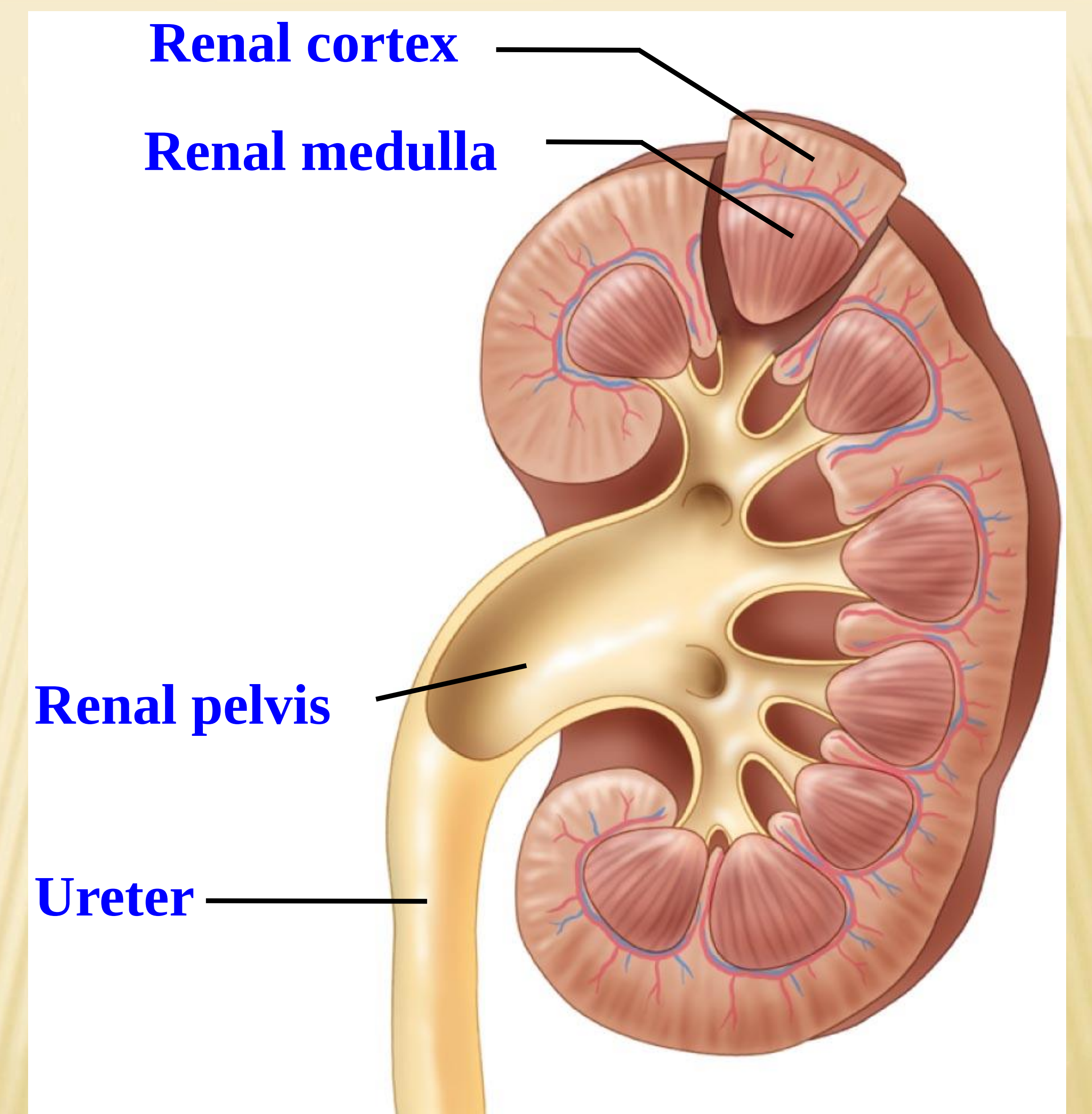
- The mammalian excretory system centers on paired kidneys, which are also the principal site of water balance and salt regulation
- Urine exits each kidney through a duct called the ureter
- Both ureters drain into a common urinary bladder, and urine is expelled through a urethra

Anatomy of the human excretory system

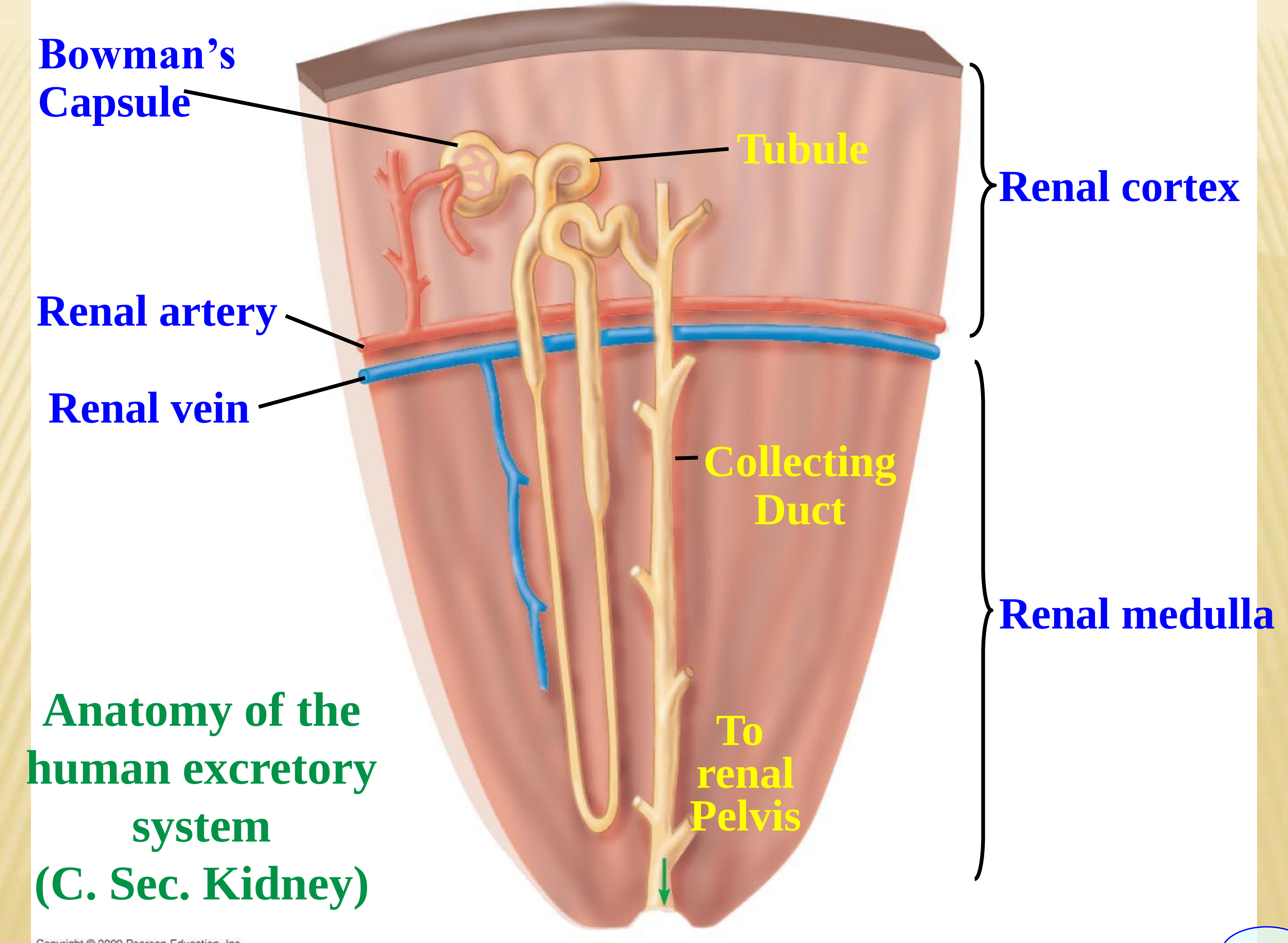


The urinary system plays several major roles in homeostasis

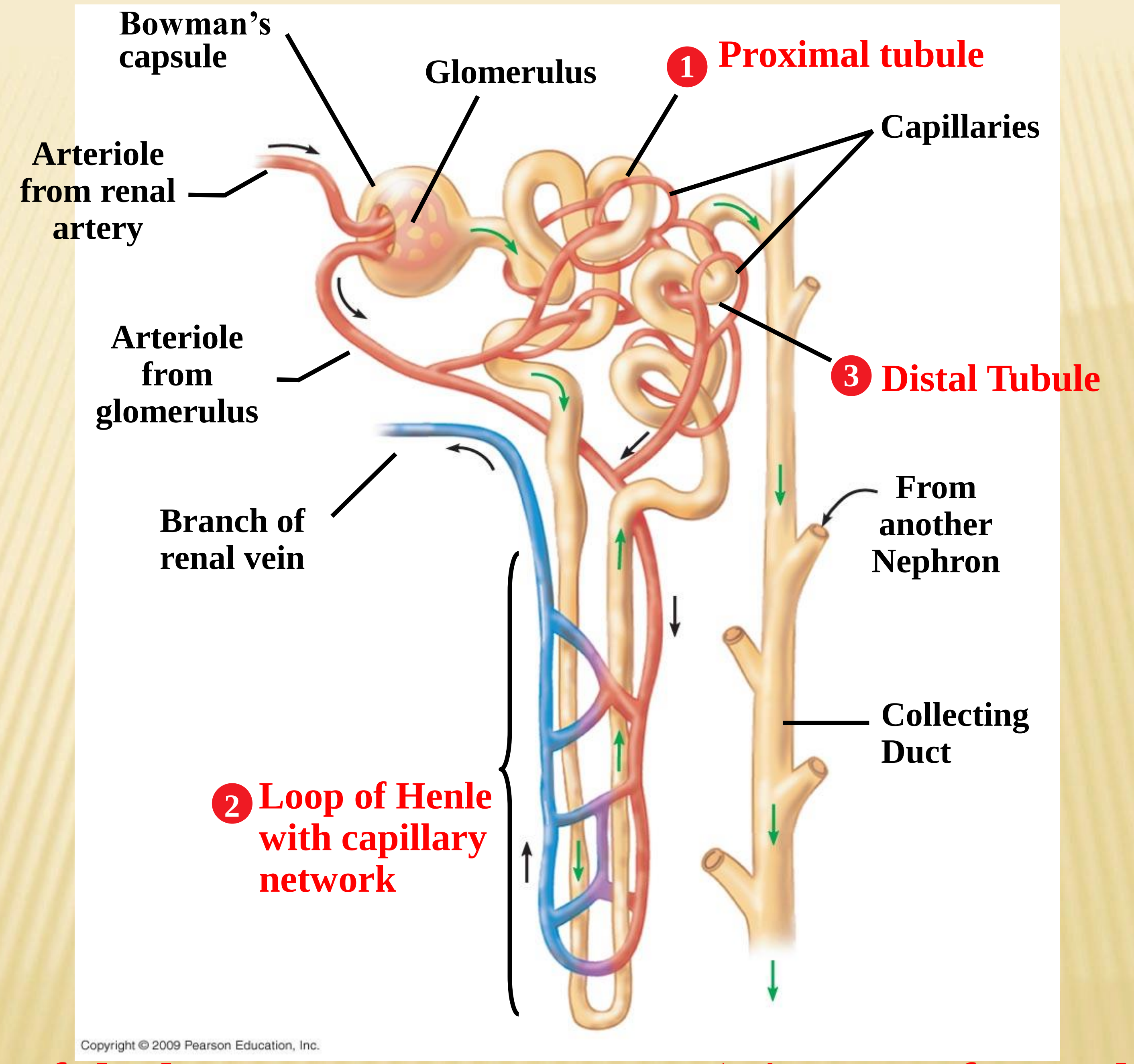
- **The excretory system**
  - **Expels wastes**
  - **Regulates water balance**
  - **Regulates ion balance**
- **Nephrons**
  - **Functional units of the kidneys**
  - **Extract a filtrate from the blood**
  - **Refine the filtrate to produce urine**



Anatomy of the human excretory system (L.Sec. Kidney)



Bowman's Capsule
Tubule
Renal cortex
Renal artery
Renal vein
Collecting Duct
Renal medulla
Anatomy of the human excretory system
(C. Sec. Kidney)
To renal Pelvis



Anatomy of the human excretory system (Diagram of a Nephron)

Excretory Processes

The key processes of the urinary system are filtration, reabsorption, secretion and excretion

1) **Filtration**

   Blood pressure forces water and many small solutes into the nephron

2) **Reabsorption**

   Valuable solutes are reclaimed from the filtrate

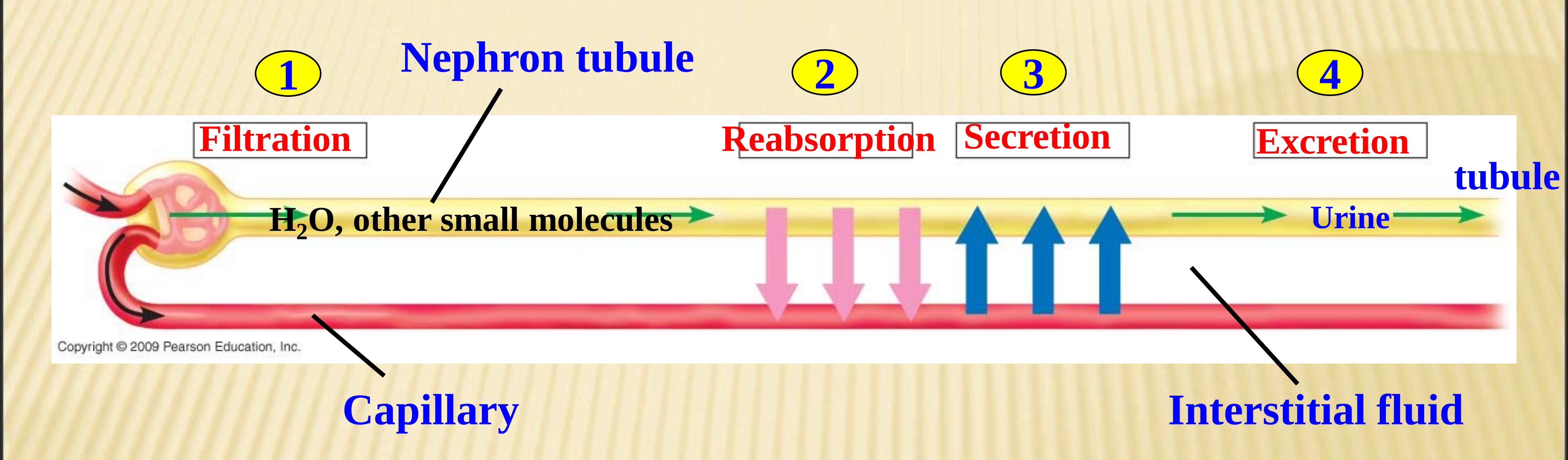
3) **Secretion**

   Excess toxins and other solutes from the body fluids are added to the filtrate

4) **Excretion**

   The final product, urine, is excreted

Major Excretory Processes of the urinary system



Blood filtrate is refined to urine through reabsorption and secretion

- **Reabsorption in the proximal and distal tubules removes Nutrients, Salt, Water**
- **pH is regulated by**
  - **Reabsorption of HCO_3^-**
  - **Secretion of H^+**
- **High NaCl concentration in the medulla promotes reabsorption of water.**
- **Antidiuretic hormone (ADH) regulates the amount of water excreted by the kidneys**

Dispose of nitrogenous wastes in animals

- **Nitrogenous wastes are toxic breakdown products of protein and nucleic acids (DNA and RNA)**
- **Animals dispose of nitrogenous wastes such as**

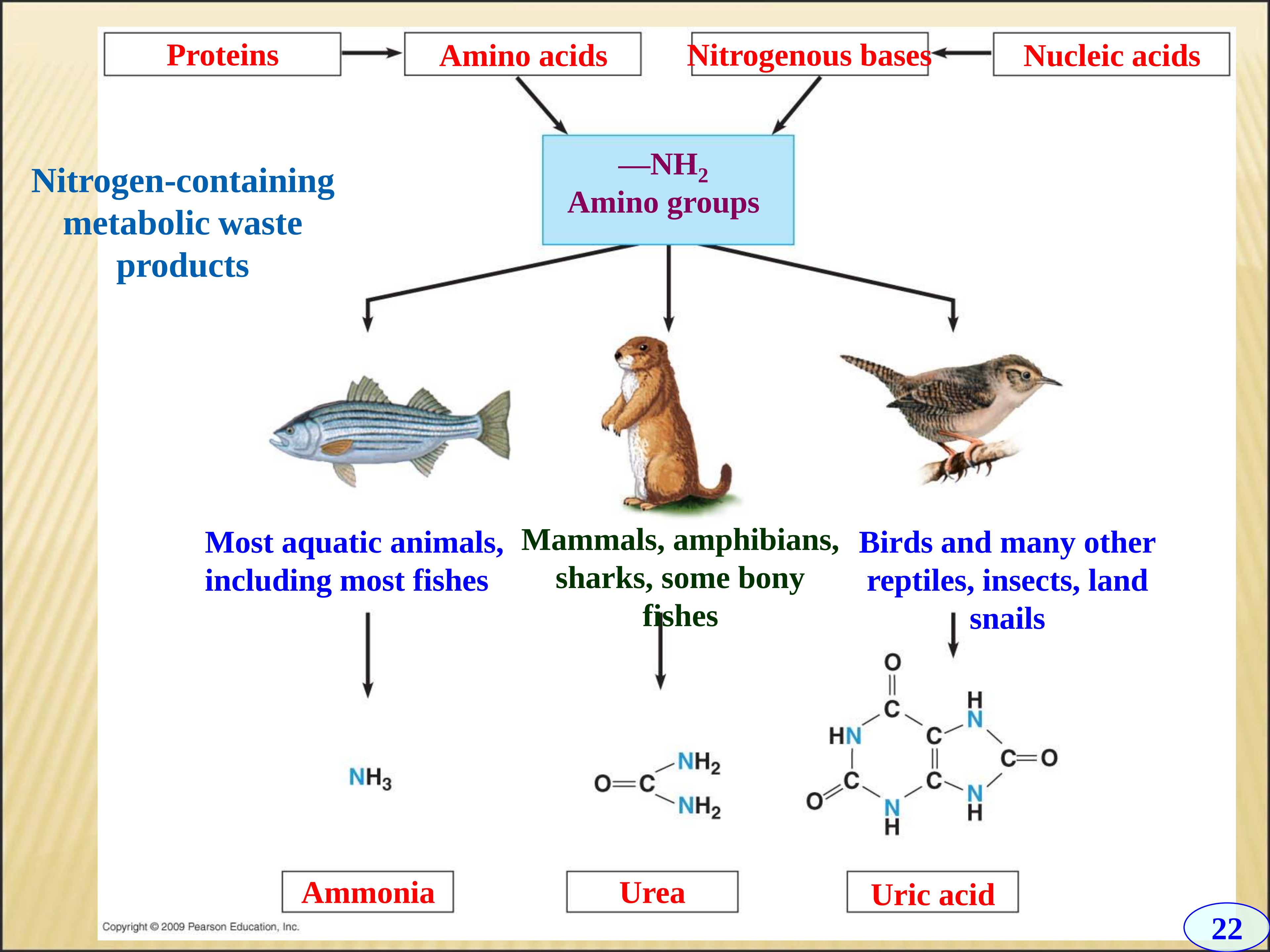
1) Ammonia (NH_3)

- **Poisonous**
- **Soluble in water**
- **Easily disposed off by aquatic animals**

2) Urea

- **Less toxic**
- **Easier to store**
- **Some land animals save water by excreting uric acid (dry waste)**

3) Urea and uric acid take energy to produce



Proteins
Amino acids
Nitrogenous bases
Nucleic acids
—NH2
Amino groups
Nitrogen-containing metabolic waste products
Most aquatic animals, including most fishes
Mammals, amphibians, sharks, some bony fishes
Birds and many other reptiles, insects, land snails
NH3
O=C NH2 NH2
HN C O N H C N H C=O C N H C O N H
Ammonia
Urea
Uric acid

Kidney dialysis can be a lifesaver

- **Compensating for kidney failure**
- **A dialysis machine**
  - **Removes wastes from the blood**
  - **Maintains its solute concentration**





Pump

Tubing made of a selectively permeable membrane

Dialyzing solution

Line from apparatus to vein

Fresh dialyzing solution

Used dialyzing solution (with urea and excess ions)

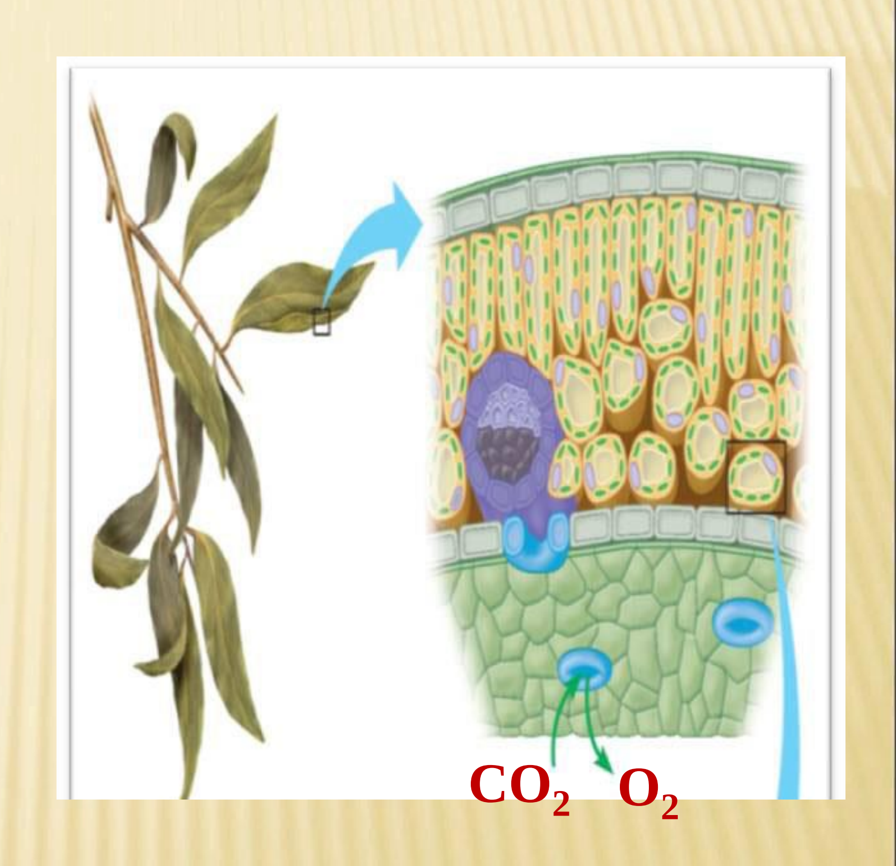
Kidney dialysis.

Excretion in Plants

Excretion in Plants

Excretion of Gases

- Excess of CO_2 or O_2 in the leaves exit through stomata to the air.
- Or they are brought by phloem and xylem from anywhere in the plant body to where there are stomata to exit to the air
- They can also penetrate external cell surfaces directly to the air

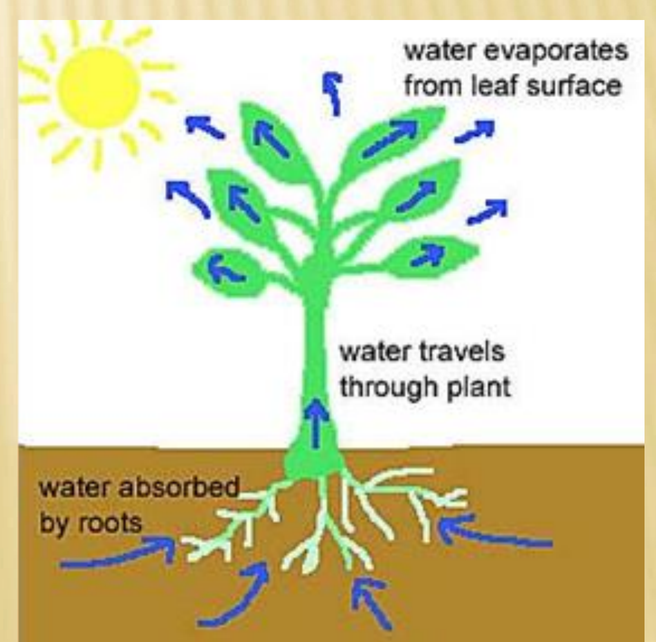


Excretion in Plants

Excretion of water

- **Guttation**
  - **Secretion of water and its solutes by hydathodes found in the leafs epidermis of some plants in hummed environment.**
- **Transpiration**
  - **Water evaporates from the surface of leaves through stomata**





Excretion in Plants

Excretion of Nitrogenous Compounds

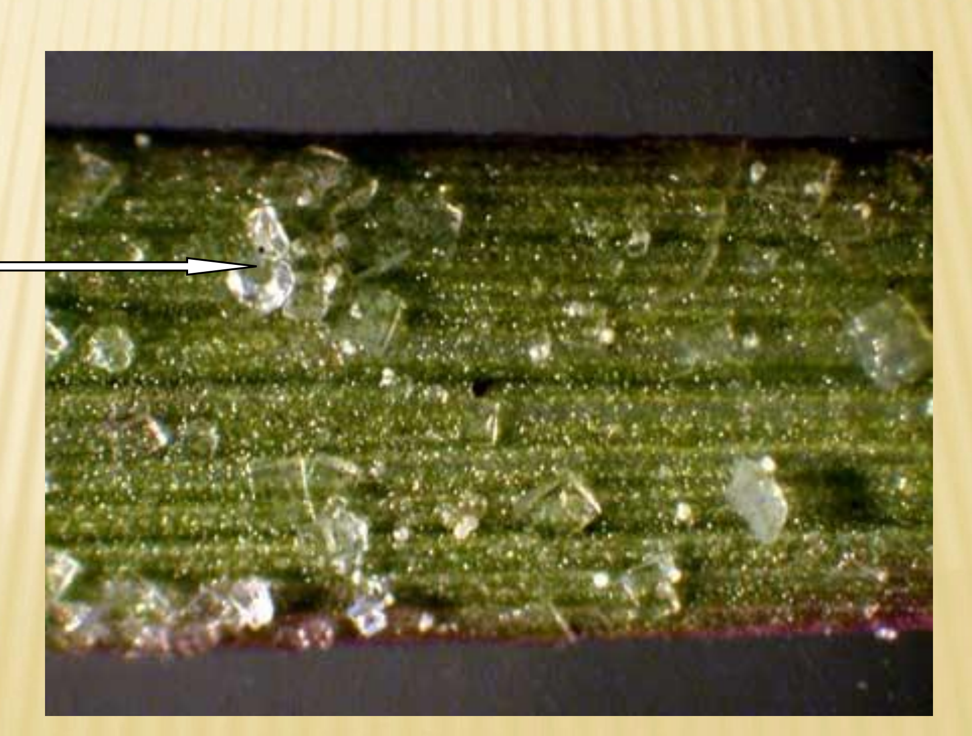
- **Terrestrial plants convert excess amino acids into uric acid and Keto acids by deamination and deposited as crystals in the leafs**
- **In Aquatic plants the excess of amino acids are converted to ammonia and keto acids; ammonia exit outside the plant through stomata**

Excretion in Plants

Excretion by Salt glands

- Excretion of excess salts outside plant body by special salt glands as in halophytes (plants grow in waters of high salinity).

Salt crystals



Chapter 11

Reproduction and Embryonic Development

ASEXUAL AND SEXUAL REPRODUCTION

Asexual reproduction results in the generation of genetically identical offspring

- **Asexual reproduction**
  - **One parent produces genetically identical offspring**
  - **Very rapid reproduction**
  - **Can proceed via**
    - **Budding**
    - **Fission**
    - **Fragmentation/ regeneration**



Asexual reproduction of an aggregating Sea anemone (*Anthopleura elegantissima*) by fission

Sexual reproduction results in the generation of genetically unique offspring

- **Some animals exhibit hermaphroditism**
  - **One individual with male and female reproductive systems**
  - **Easier to find a mate for animals less mobile or solitary**

Hermaphroditic earthworms mating



Sexual reproduction results in the generation of genetically unique offspring

- Sperm may be transferred to the female by
  - External fertilization
    - Many fish and amphibian species
    - Eggs and sperm are discharged near each other
  - Internal fertilization
    - Some fish and amphibian species
    - Nearly all terrestrial animals
    - Sperm is deposited in or near the female reproductive tract



Frogs in an embrace that triggers the release of eggs and sperm

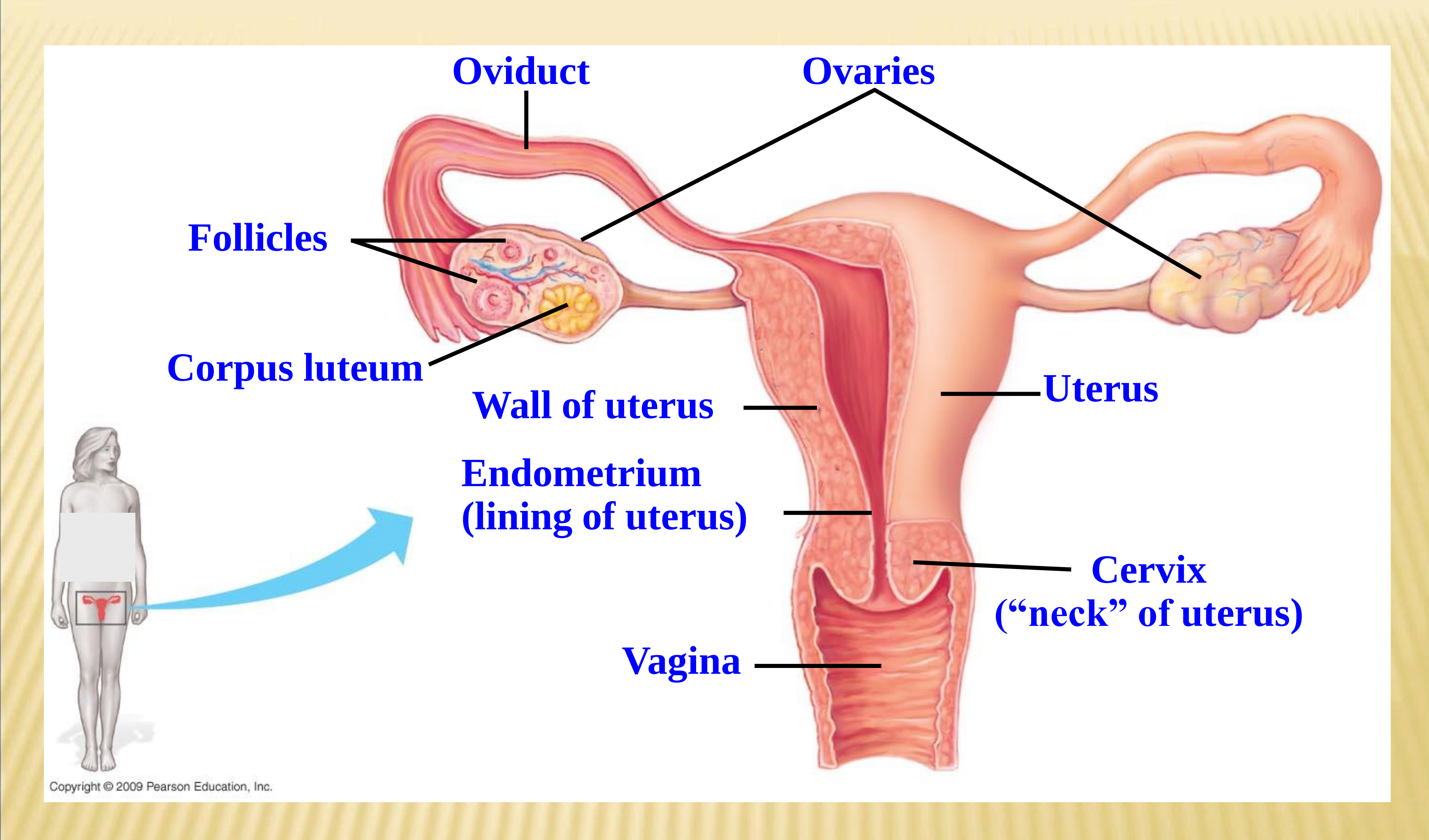
Human Reproduction

Reproductive anatomy of the human female

- **Both sexes in humans have**
  - **A set of gonads where gametes (sperms & ova) are produced**
  - **Ducts for gamete transport**
  - **Structures for copulation**

Human Female Reproductive anatomy

- **Ovaries contain follicles that Nurture eggs and Produce sex hormones**
- **Oviducts convey eggs to the uterus where embryos develop**
- **The uterus opens into the vagina through the cervix**
- **The vagina**
  - **Receives the penis during sexual intercourse**
  - **Forms the birth canal**



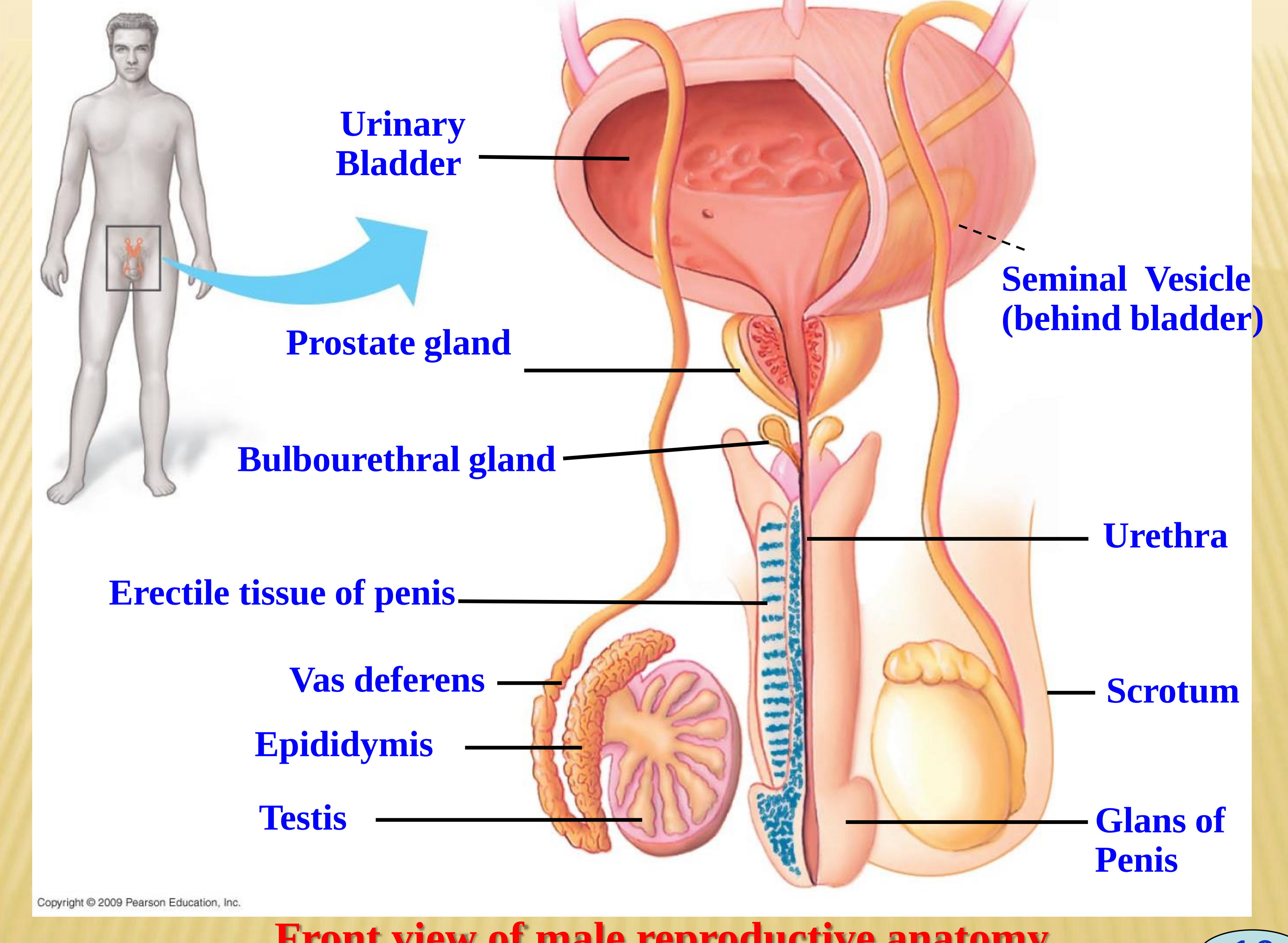
Front view of female reproductive anatomy (upper portion)

Human Male Reproductive anatomy

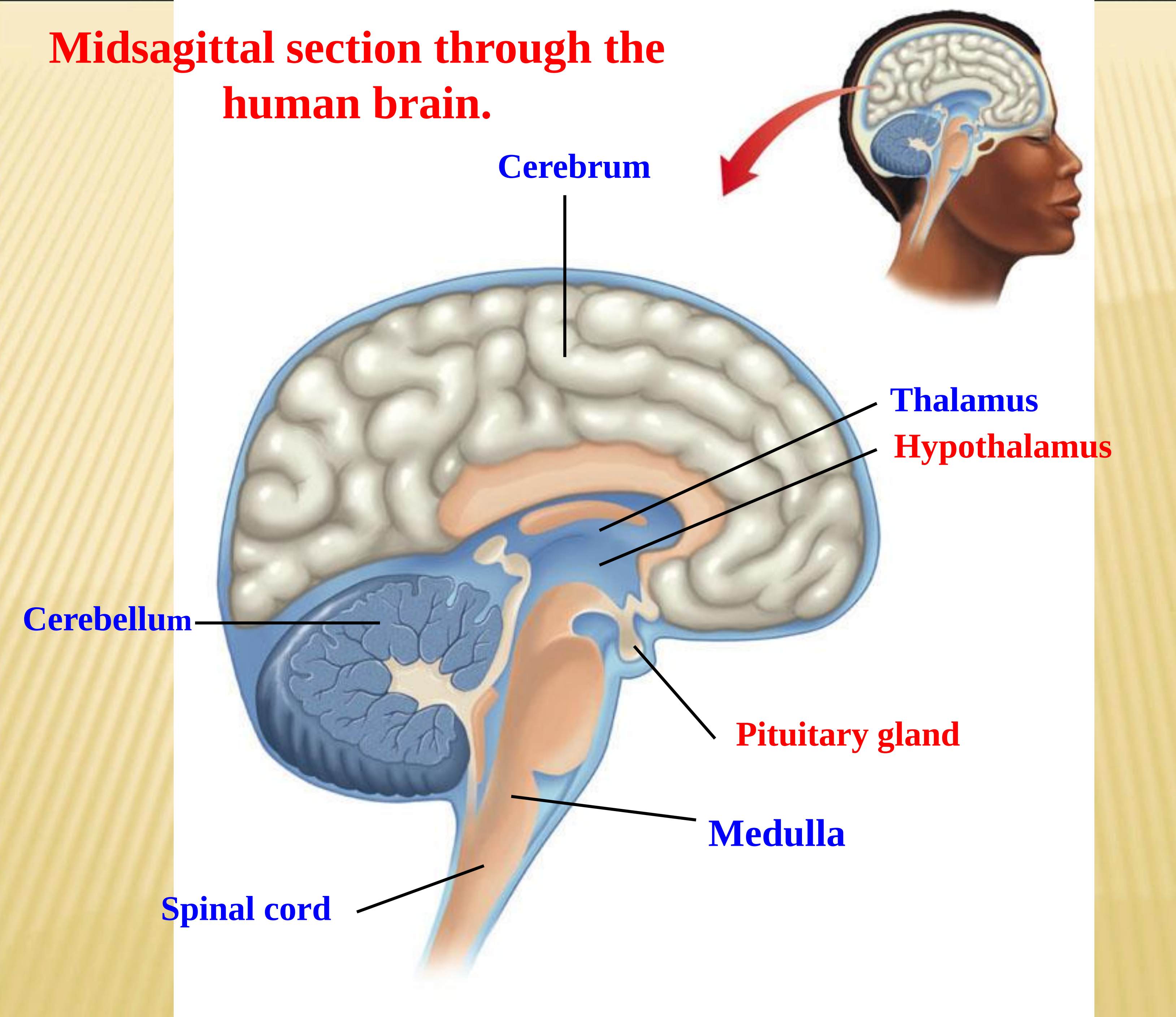
- Testes (singular *testis*) produce Sperm and male hormones
- Epididymis stores sperm as they develop further
- Several glands contribute to semen
  - Seminal vesicles
  - Prostate
  - Bulbourethral

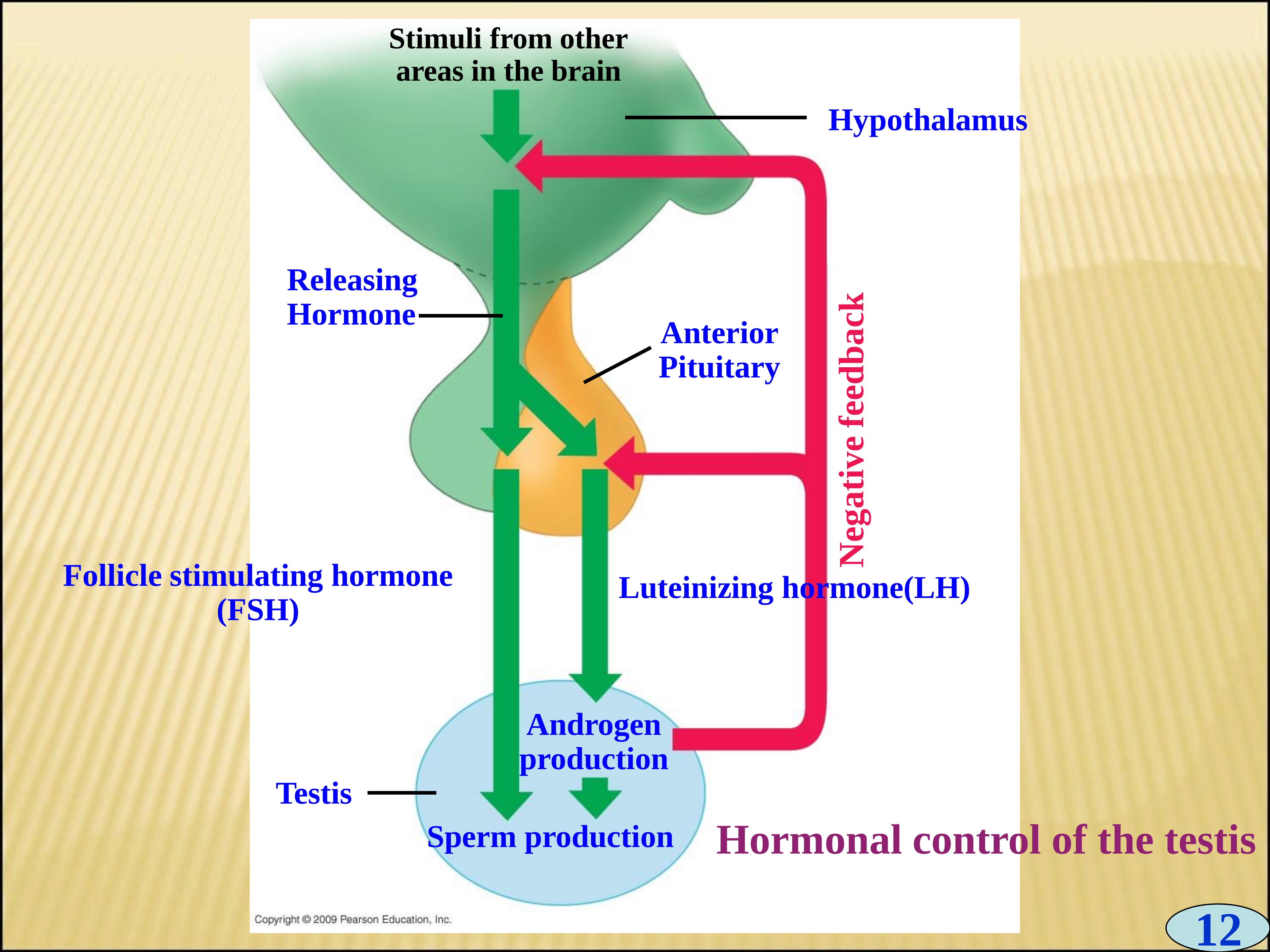
Sperm production (Spermatogenesis)

- Regulated by a negative feedback system of hormones
- Involves the hypothalamus, pituitary, and testes



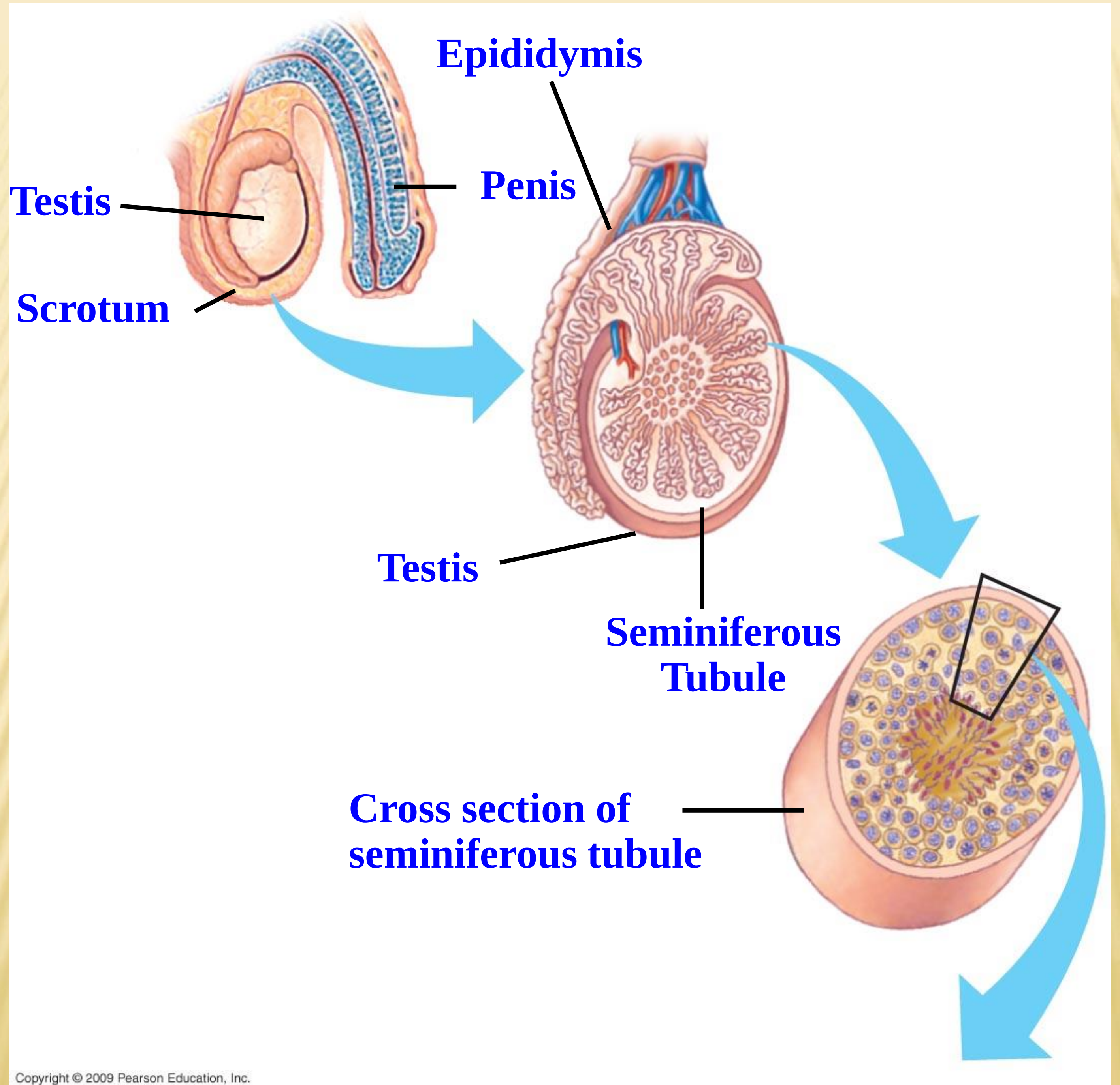
Front view of male reproductive anatomy

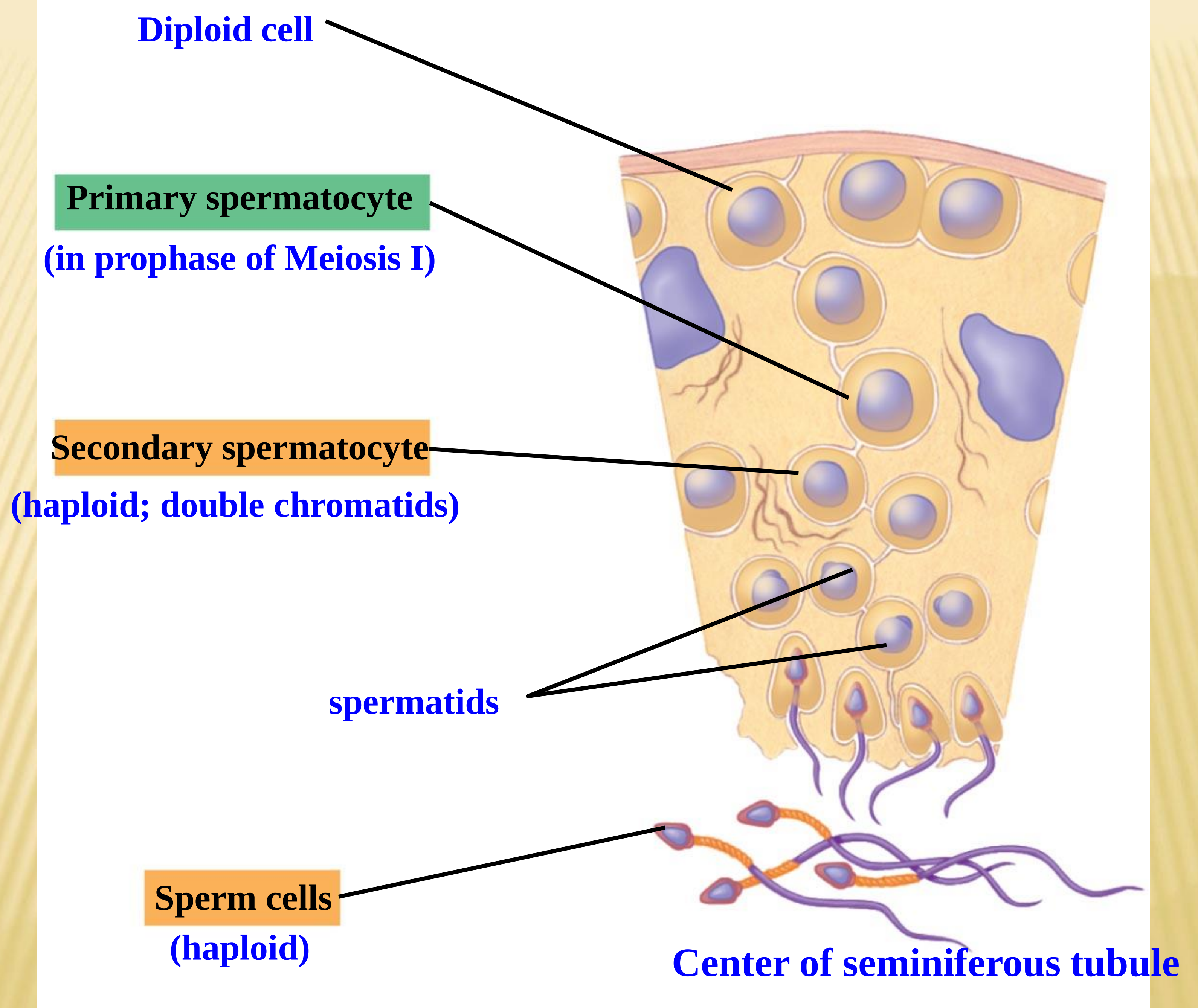

Midsagittal section through the human brain.
Cerebrum
Thalamus
Hypothalamus
Cerebellum
Pituitary gland
Medulla
Spinal cord
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Stimuli from other areas in the brain
Hypothalamus
Releasing Hormone
Anterior Pituitary
Negative feedback
Follicle stimulating hormone (FSH)
Luteinizing hormone(LH)
Androgen production
Testis
Sperm production
Hormonal control of the testis
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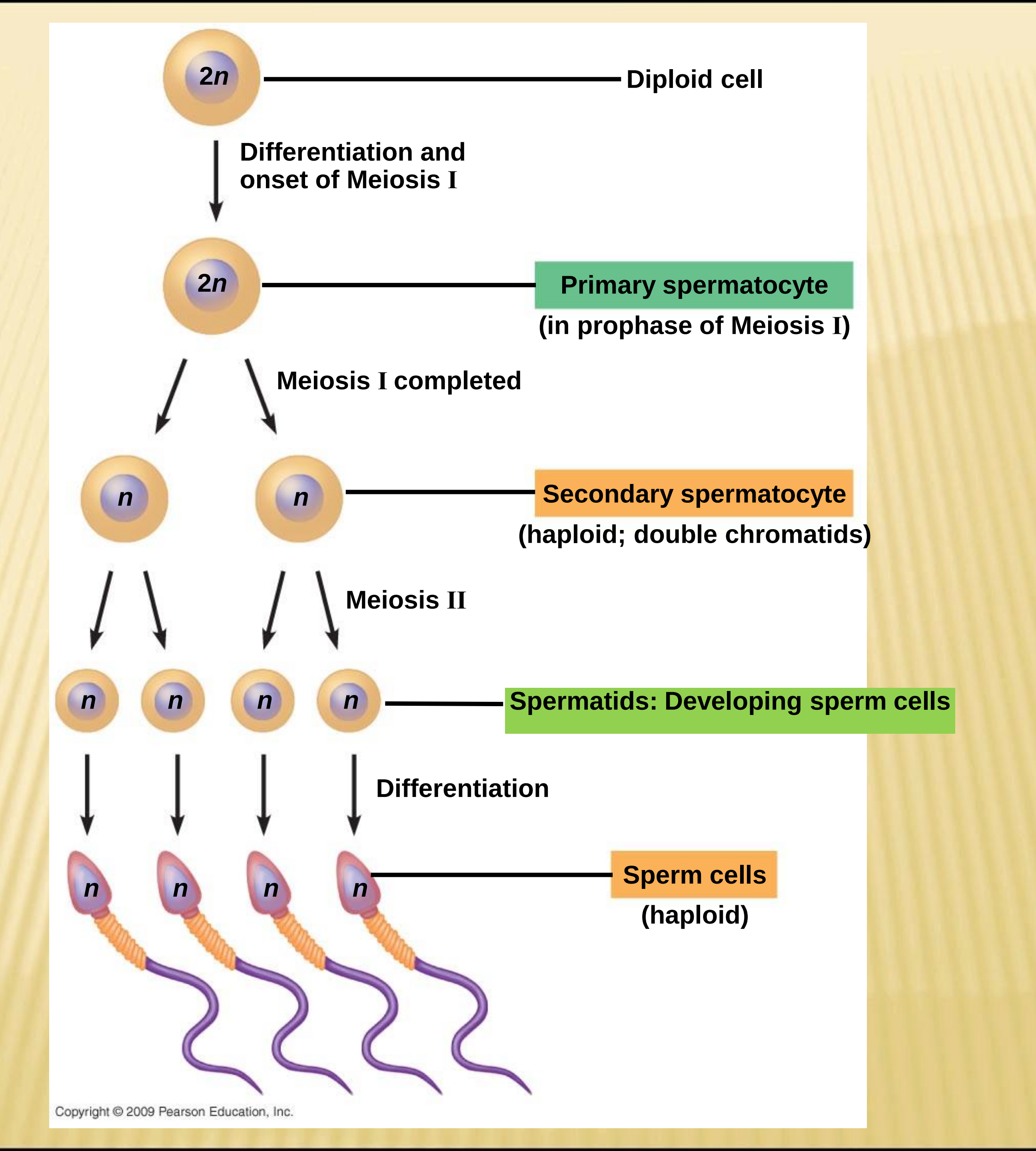
Spermatogenesis (The formation of sperm)

- Spermatogenesis
  - Occurs in seminiferous tubules
  - Primary spermatocytes
    - Formed by mitosis
    - Divide by meiosis I to produce secondary spermatocytes
  - Secondary spermatocytes divide by meiosis II to produce spermatids
  - Round spermatids differentiate into elongate sperm
  - Mature sperm released into seminiferous tubule and stored in the epididymis


Epididymis
Penis
Testis
Scrotum
Testis
Seminiferous Tubule
Cross section of seminiferous tubule
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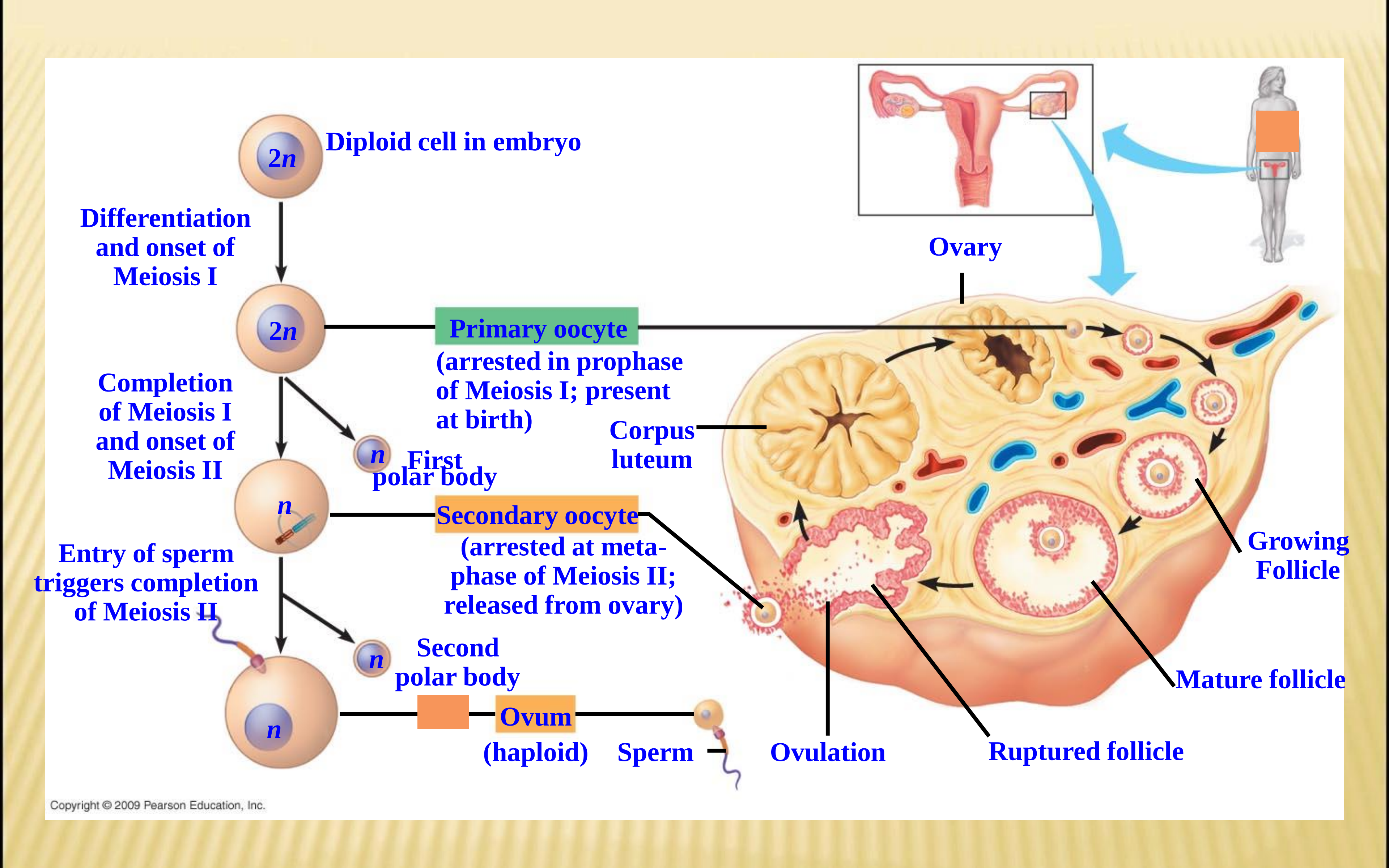


Diploid cell
Primary spermatocyte
(in prophase of Meiosis I)
Secondary spermatocyte
(haploid; double chromatids)
spermatids
Sperm cells
(haploid)
Center of seminiferous tubule
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2n
Diploid cell
Differentiation and
onset of Meiosis I
2n
Primary spermatocyte
(in prophase of Meiosis I)
Meiosis I completed
n
n
Secondary spermatocyte
(haploid; double chromatids)
Meiosis II
n
n
n
n
Spermatids: Developing sperm cells
Differentiation
n
n
n
n
Sperm cells
(haploid)
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Oogenesis (The formation of egg)

- **Oogenesis**
  - **Begins before birth: diploid cells start meiosis and stop**
  - **Each month about one primary oocyte resumes meiosis**
  - **A secondary oocyte arrested at metaphase of meiosis II is ovulated**
  - **Meiosis of the ovum is completed after fertilization**



Oogenesis and the development of an ovarian follicle

Hormones synchronize cyclic changes in the ovary and uterus

- **Ovarian and menstrual cycles**

Occur about every 28 days

Hypothalamus signals the anterior pituitary to secrete follicle-stimulating hormone (FSH) and leuteinizing hormone (LH), which trigger

- **Growth of a follicle**
- **Ovulation**

Hormones synchronize cyclic changes in the ovary and uterus

- **After ovulation, empty ovarian follicle becomes corpus luteum**
- **Corpus luteum secretes estrogen and progesterone hormones, which**
  1) **Stimulate the endometrium to thicken**
  2) **Prepare the uterus for implantation of the embryo**
  3) **Inhibit hypothalamus, reducing FSH and LH secretion**

Hormones synchronize cyclic changes in the ovary and uterus

- **If egg is fertilized**
  - **Embryo releases hormones that maintain the uterine lining**
  - **Menstruation does not occur**
- **If egg is not fertilized**
  - **Drop in LH shuts down corpus luteum and its hormones**
  - **Menstruation is triggered**
  - **Hypothalamus and pituitary stimulate development of a new follicle**

Embryonic Development

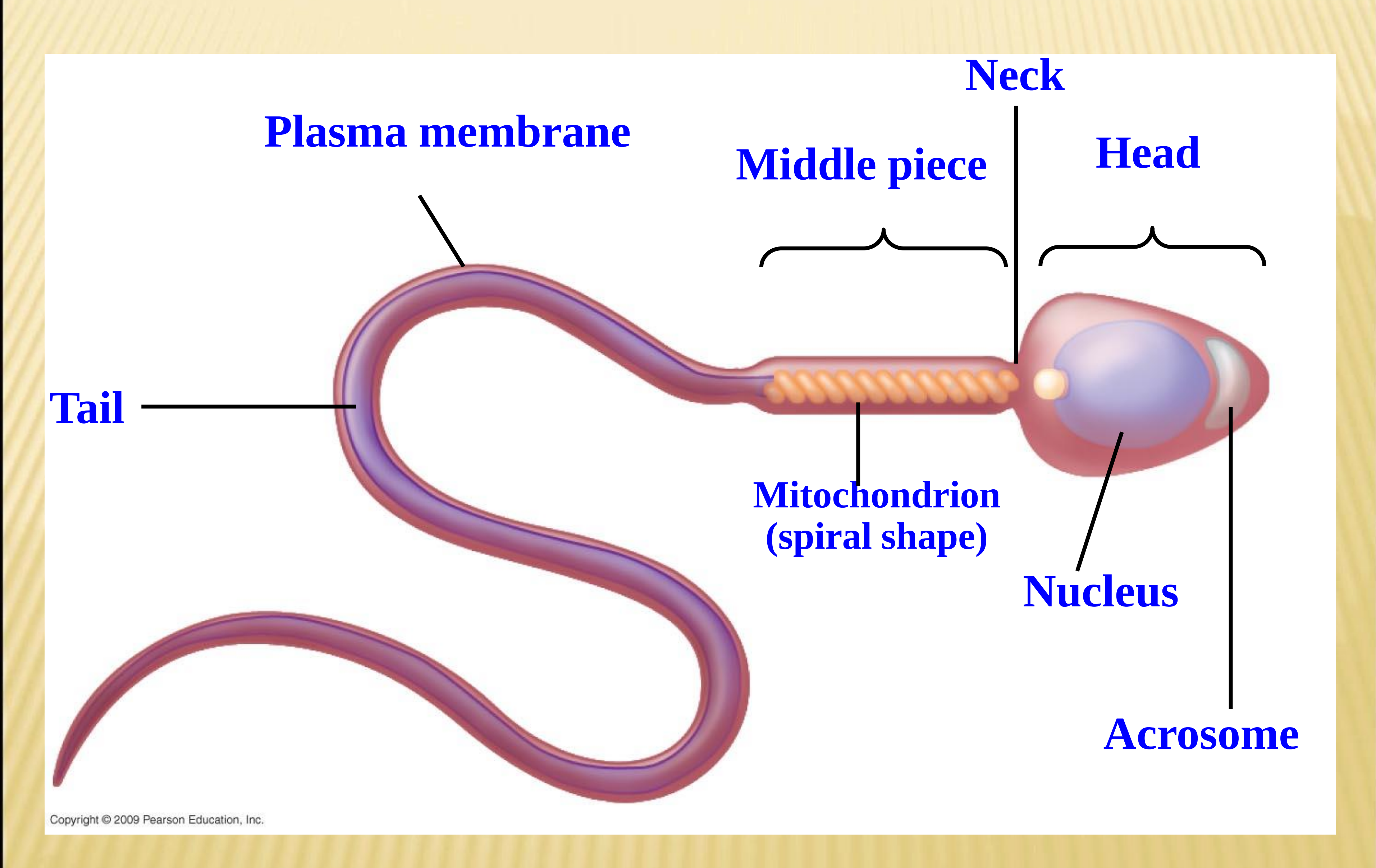
- Embryonic development begins with fertilization
- Fertilization is the union of sperm and egg to form a diploid zygote
- Resulted zygote triggers embryonic development

Fertilization

Sperm adaptation

Sperm are adapted to reach and fertilize an egg

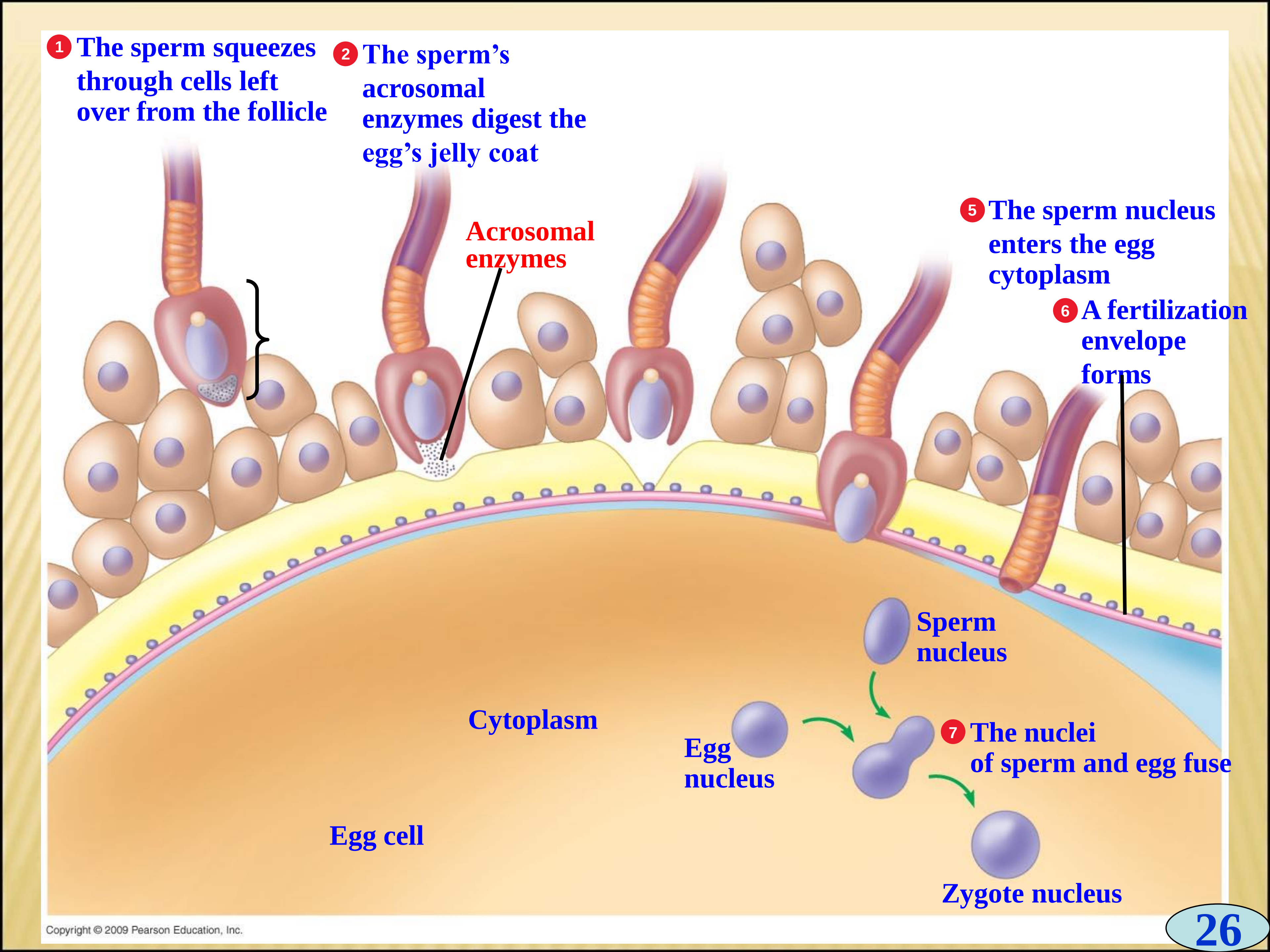
- **Streamlined shape moves more easily through fluids**
- **Many mitochondria provide ATP for tail movements**
- **Head contains a haploid nucleus Tipped with an acrosome containing penetrating enzymes**



The structure of a human sperm cell

Fertilization results in a zygote and triggers embryonic development

- **Fertilization events**
  - **Sperm squeeze past follicle cells**
  - **Acrosomal enzymes pierce egg's coat**
  - **Sperm binds to vitelline layer**
  - **Sperm and egg plasma membranes fuse**
  - **Egg is stimulated to develop further**
  - **Egg and sperm nuclei fuse**

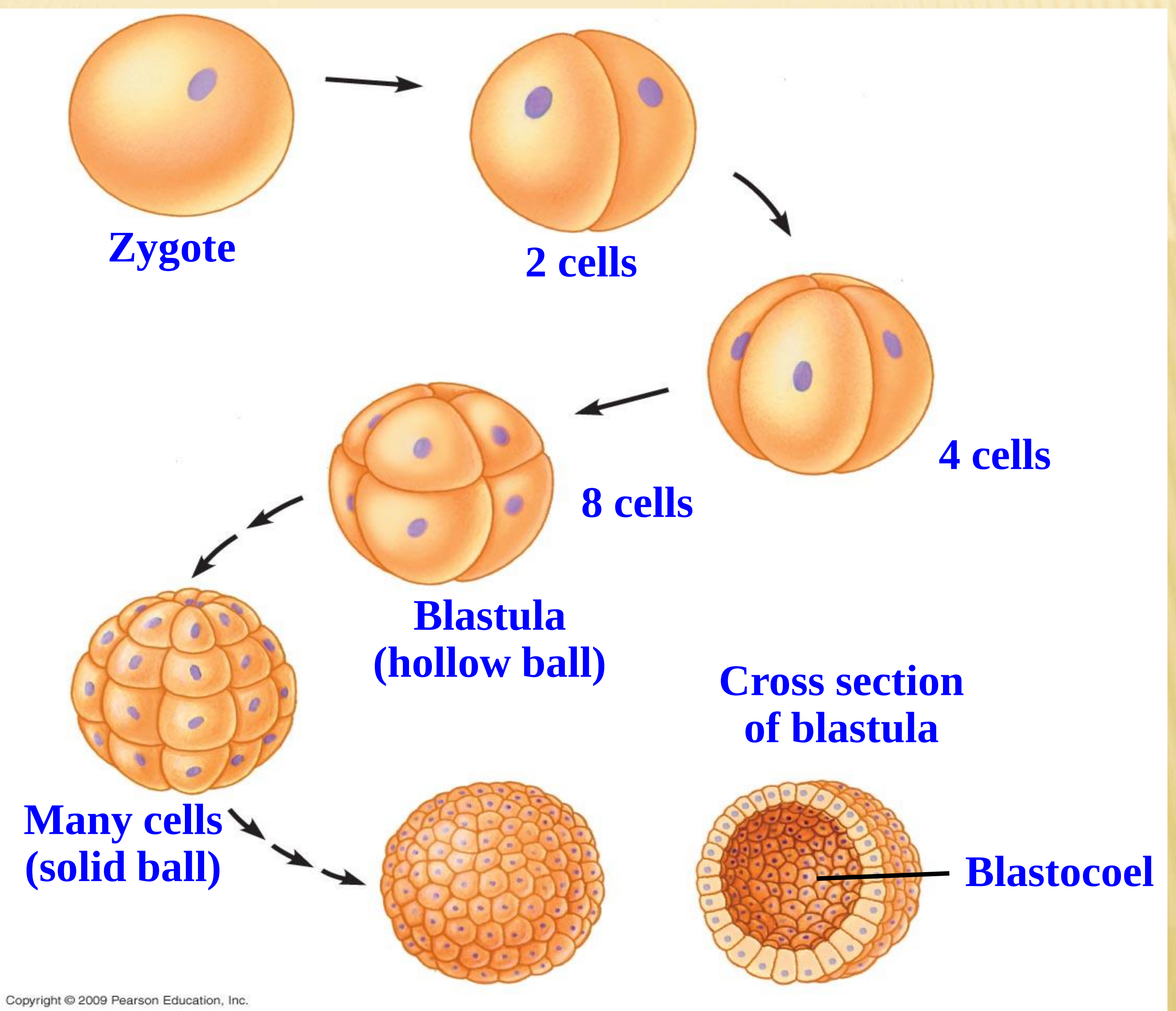


1 The sperm squeezes through cells left over from the follicle
2 The sperm's acrosomal enzymes digest the egg's jelly coat
Acrosomal enzymes
5 The sperm nucleus enters the egg cytoplasm
6 A fertilization envelope forms
Sperm nucleus
Cytoplasm
Egg nucleus
7 The nuclei of sperm and egg fuse
Egg cell
Zygote nucleus

Embryonic development
1. Cleavage

- **Cleavage is a rapid series of cell divisions**
- **Cleavage produces a ball of cells from the zygote**
  - **More cells**
  - **Embryo does not get larger**
  - **Thus new cells are smaller in size**
  - **A ball of cells called blastula is formed at the end of cleavege**

Cleavage


Zygote
2 cells
4 cells
8 cells
Blastula
(hollow ball)
Cross section
of blastula
Many cells
(solid ball)
Blastocoel
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2. Gastrulation produces a three-layered embryo

- **Gastrulation**
- **The blastula (ball of similar cells) resulted from cleavage go to gastrulation**
  - **Cells migrate**
  - **The basic body plan of three layers is established**
    - **Ectoderm outside - becomes skin and nervous systems**
    - **Endoderm inside - becomes digestive tract**
    - **Mesoderm in middle - becomes muscle and bone**

Development of the frog gastrula

Blastula
(end of cleavage)

Gastrulation
(cell migration)

Gastrula
(end of gastrulation)

Ectoderm

Mesoderm

Endoderm

Simple
digestive
cavity

CHAPTER 12

GENETICS

Topics Discussed in this chapter

Cell Division

- Sexual and asexual reproduction
- Binary fission
- Eukaryotic Cell Cycle
- Chromatin and chromosomes

Mitosis and Meiosis

- Phases of mitosis
- Phases of meiosis
- Tetrads, synapsis and crossing over
- Somatic cells and sex cells
- Autosomes and sex chromosomes

CELL DIVISION

and

REPRODUCTION

Methods of Reproduction

- **Living organisms reproduce by two methods**

  1. Asexual reproduction

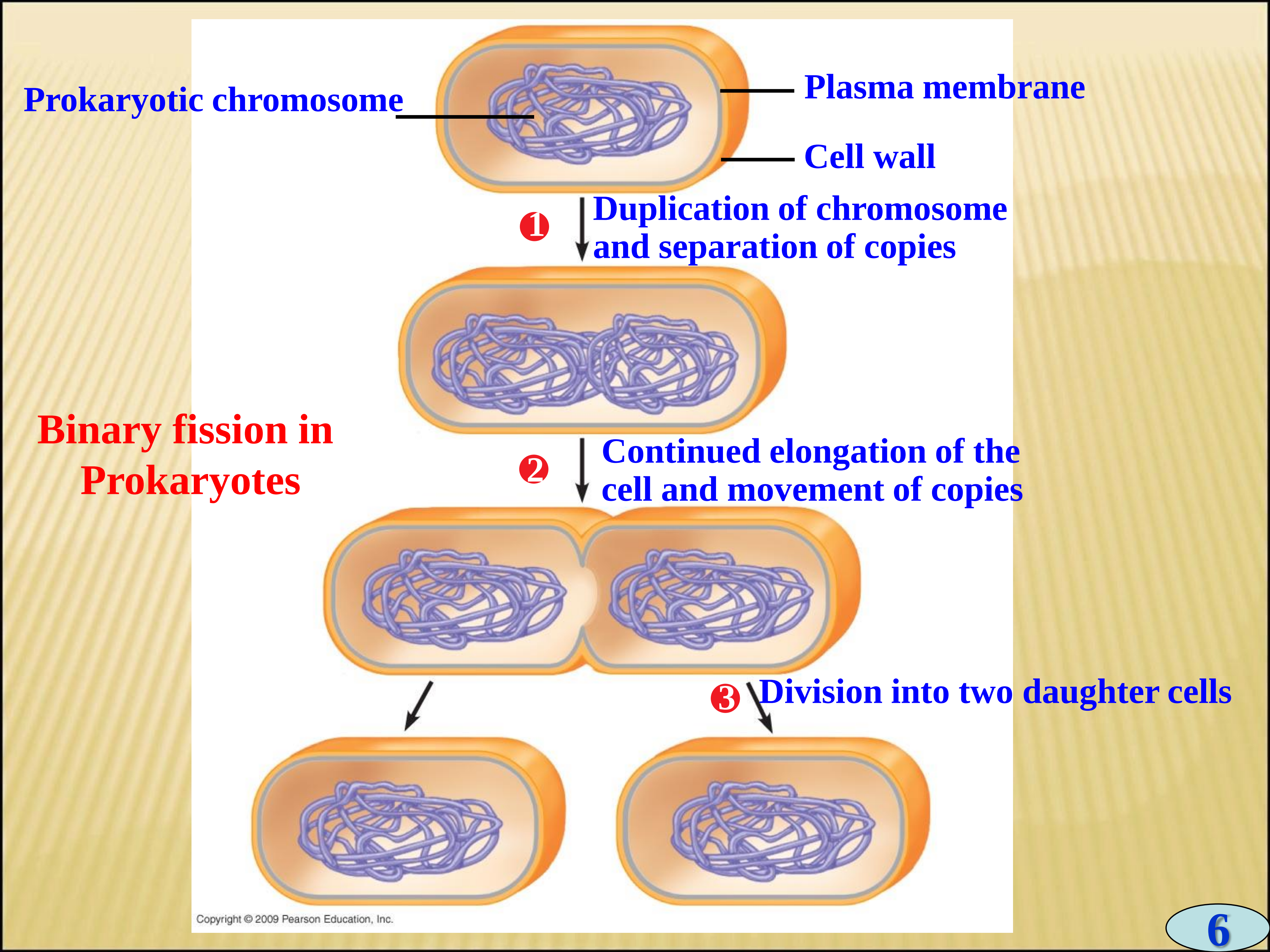
  - **Offspring are identical to the original cell or organism**
  - **Involves inheritance of all genes from one parent**
  - **Prokaryotes reproduce asexually by binary fission.**

  2. sexual reproduction

  - **Involves inheritance of unique sets of genes from two parents**
  - **Offspring are similar to parents, but show variations in traits**

Prokaryotes reproduce by binary fission

- **Binary fission means "dividing in half"**
  - **Occurs in prokaryotic cells**
  - **Two identical cells arise from one cell**
  - **Steps in the process:**
    - **A single circular chromosome duplicates, and the copies begin to separate from each other**
    - **The cell elongates, and the chromosomal copies separate further**
    - **The plasma membrane grows inward at the midpoint to divide the cells**


Prokaryotic chromosome
Plasma membrane
Cell wall
❶ Duplication of chromosome and separation of copies
Binary fission in Prokaryotes
❷ Continued elongation of the cell and movement of copies
❸ Division into two daughter cells
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Eukaryotic Cell Division and Cell Cycle

The cell cycle is an ordered sequence of events for cell division.

- **Cells divide when they reach a certain size.**
- **The cell cycle consists of two stages**

1. **Interphase: Includes G1, S, and G2 phases during which cell contents are duplication .**

G1: first gap phase, growth and prepares for S-phase

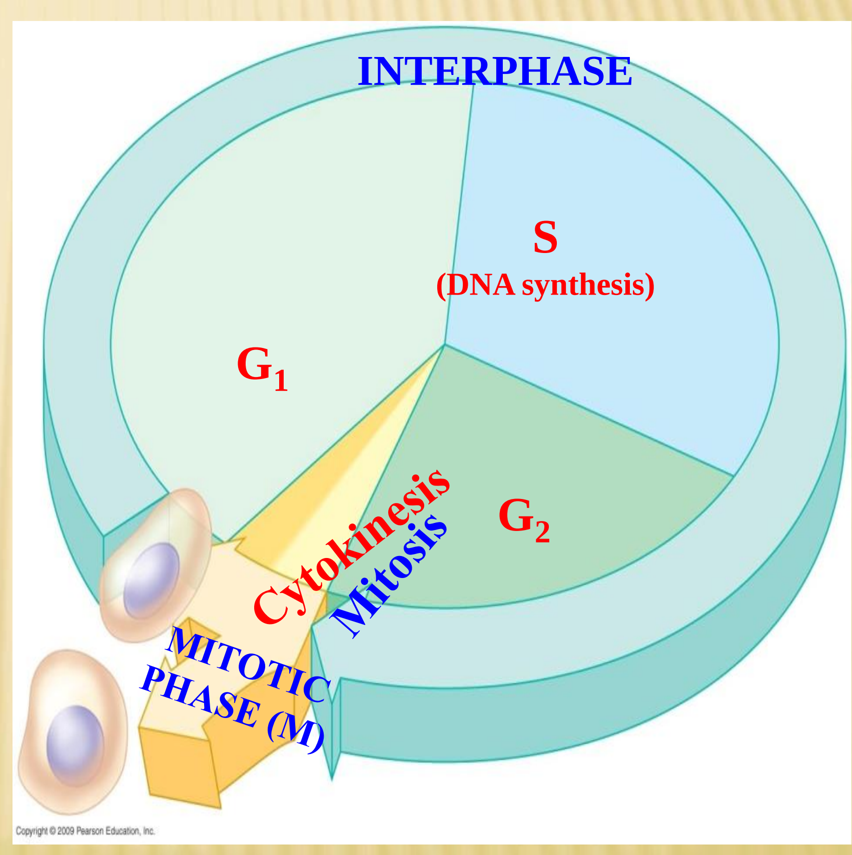
S: DNA synthesis phase, duplication of chromosomes, each becomes two sister chromatids

G2: second gap phase, growth and preparation for division

2. **Mitotic phase: (the M phase) involves mitosis and cytokinesis.**

Mitosis: division of the chromosomes

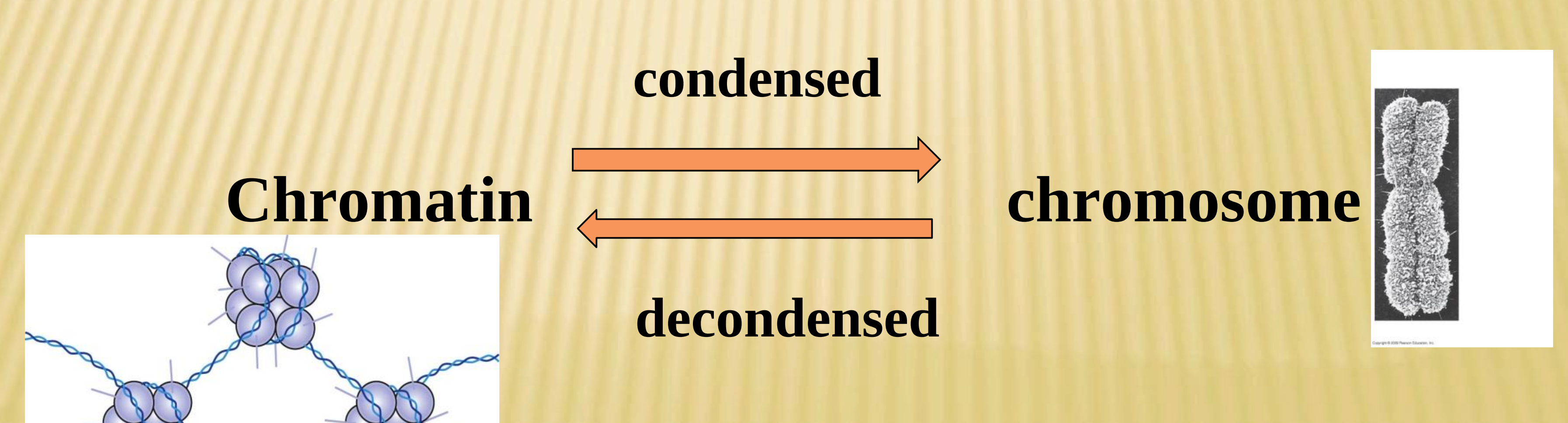
Cytokinesis: division of cytoplasm



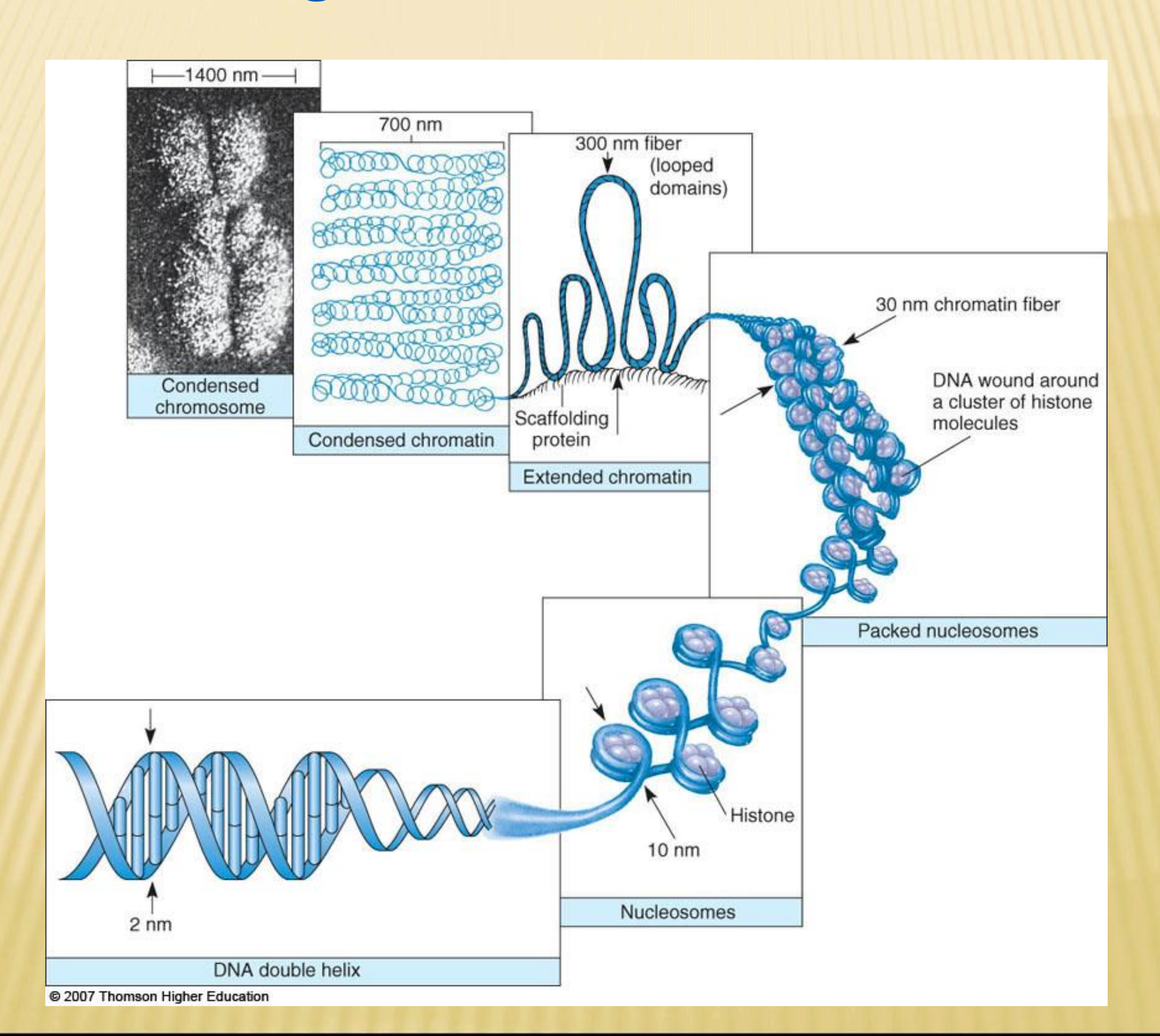
The eukaryotic cell cycle

Eukaryotic chromosomes

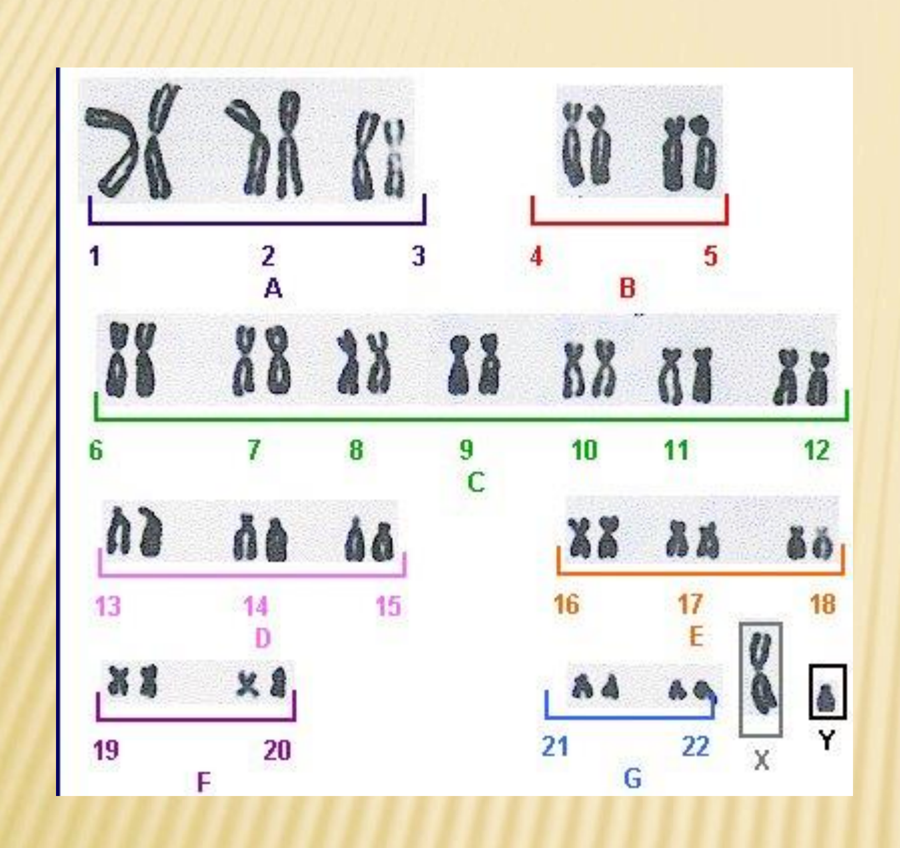
- The chromosomes carry the genetic information.
- Eukaryotic chromosomes contain DNA and protein
- The chromosomes are so named because they may be stained by certain dyes
- When cells are not dividing, the genetic material is decondensed and is called chromatin
- When cells are dividing, the genetic material is condensed and is called chromosome



Chromosome Organization



Chromosomes, Mitosis and Meiosis



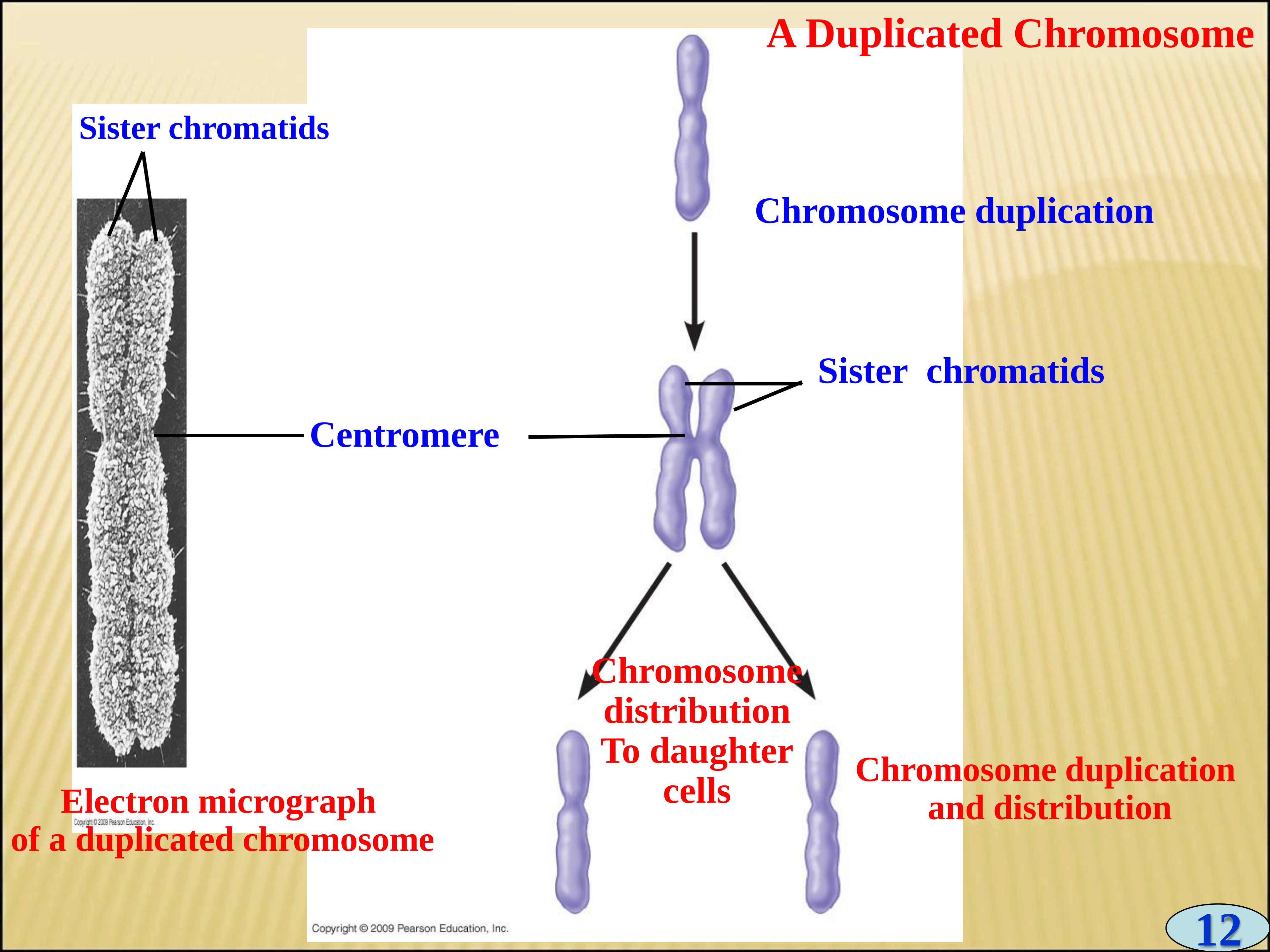
Human chromosomes karyotype



Human chromosomes metaphase spread

The large, complex chromosomes of eukaryotes duplicate with each cell division

- **Early in the division process, chromosomes duplicate in S-phase.**
- **Each chromosome appears as two sister chromatids containing identical DNA molecules.**
- **Sister chromatids are joined at a narrow region called the centromere.**


A Duplicated Chromosome
Sister chromatids
Chromosome duplication
Sister chromatids
Centromere
Chromosome distribution To daughter cells
Chromosome duplication and distribution
Electron micrograph of a duplicated chromosome
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Mitosis

- **Identical chromosomes are distributed to each daughter cell**
- **Mitosis preserves chromosome number in eukaryotic cell**

Stages of Mitosis

- **Mitosis: progresses through a series of stages:**

1.Prophase:Chromatin condenses into duplicated chromosomes (pair of sister chromatids) and chromosomes become visible.

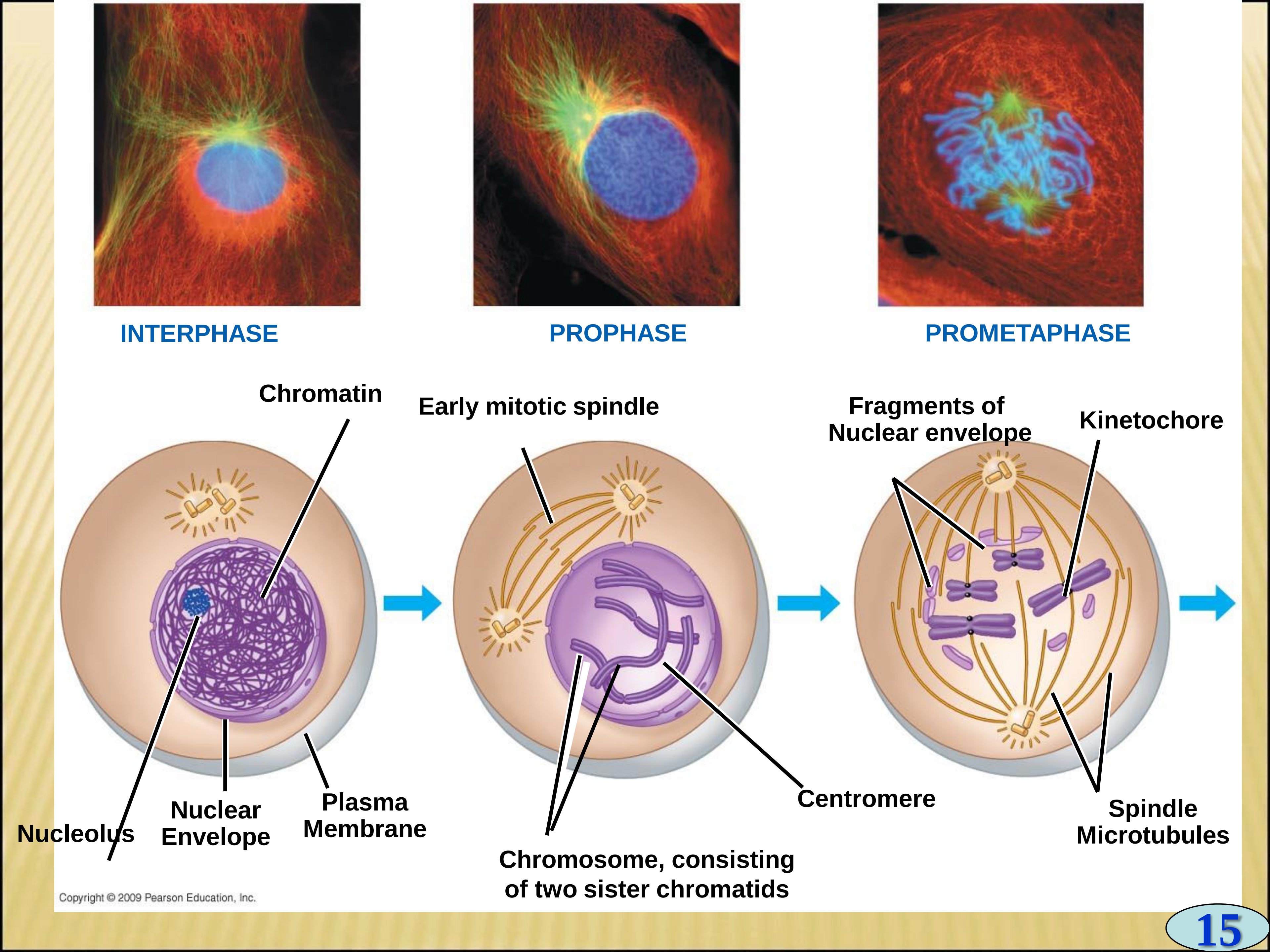
2.Prometaphase:Chromosomes begin to move toward cell's midplan.

3. Metaphase: Chromosomes align on cell's midplane on top of each other.

4.Anaphase: Sister chromatids separate, move to opposite poles. Each former chromatid is now a chromosome.

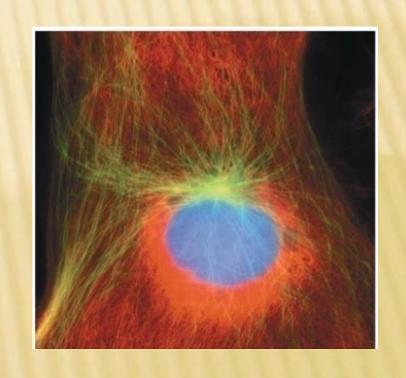
5.Telophase: Chromosomes decondensed. Cytokinesis begins

Cytokinesis: Cytoplasmic division. Often overlaps telophase


INTERPHASE
PROPHASE
PROMETAPHASE
Chromatin
Early mitotic spindle
Fragments of
Nuclear envelope
Kinetochore
Nucleolus
Nuclear
Envelope
Plasma
Membrane
Centromere
Spindle
Microtubules
Chromosome, consisting
of two sister chromatids

Cell division is a continuum of dynamic changes

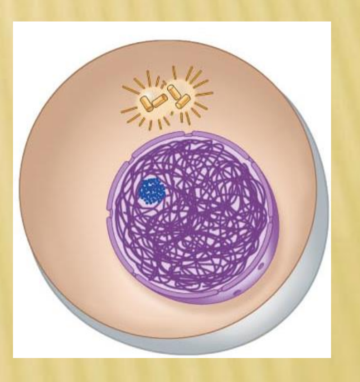
- **Interphase**

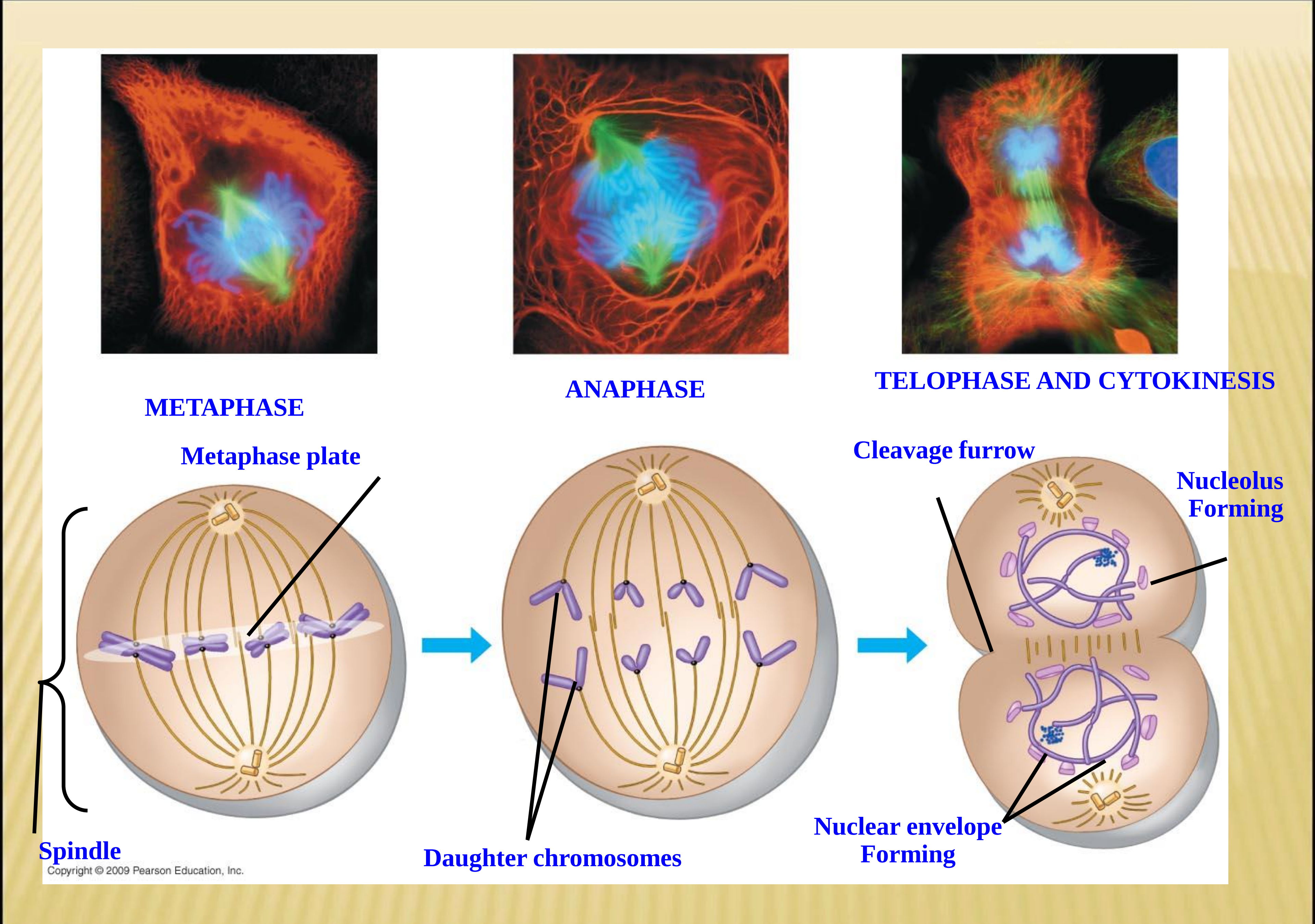


  – **In the cytoplasm**
    – **Cytoplasmic contents double**



  – **In the nucleus**
    Chromosomes duplicate during the S phase

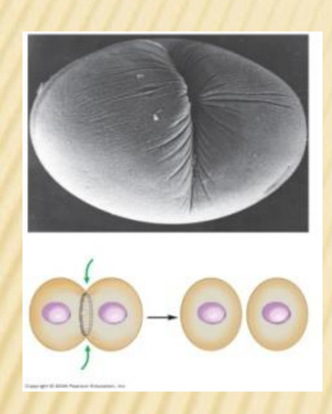




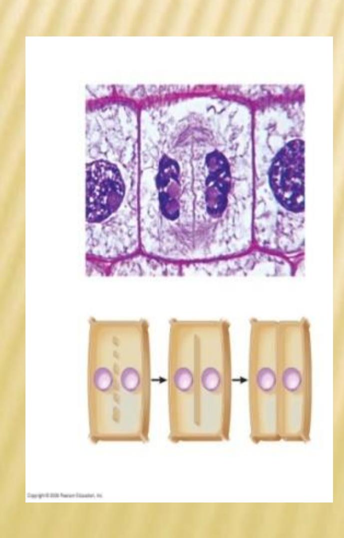
METAPHASE
ANAPHASE
TELOPHASE AND CYTOKINESIS
Metaphase plate
Cleavage furrow
Nucleolus
Forming
Spindle
Daughter chromosomes
Nuclear envelope
Forming
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Cytokinesis differs for plant and animal cells

- Cytokinesis

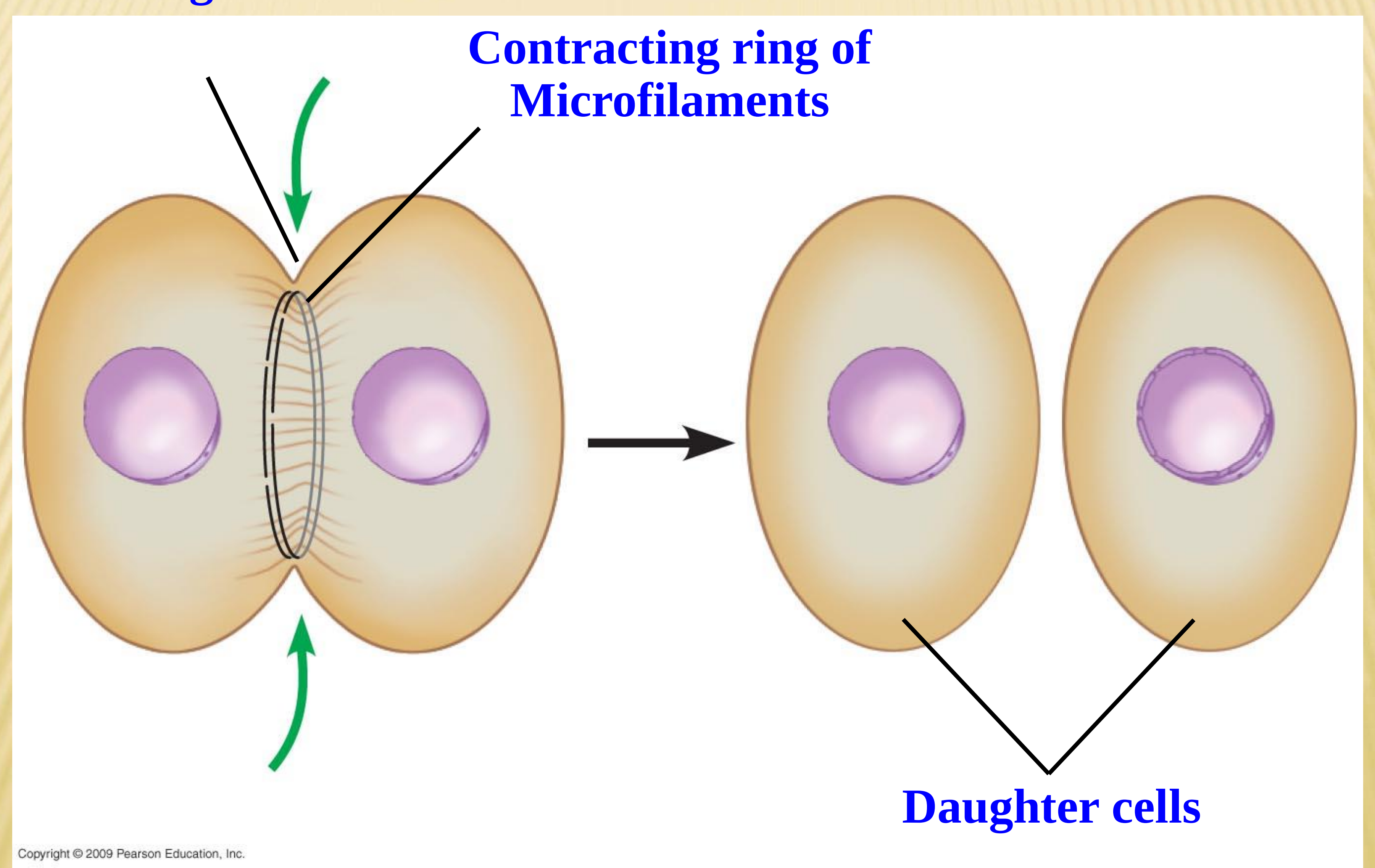


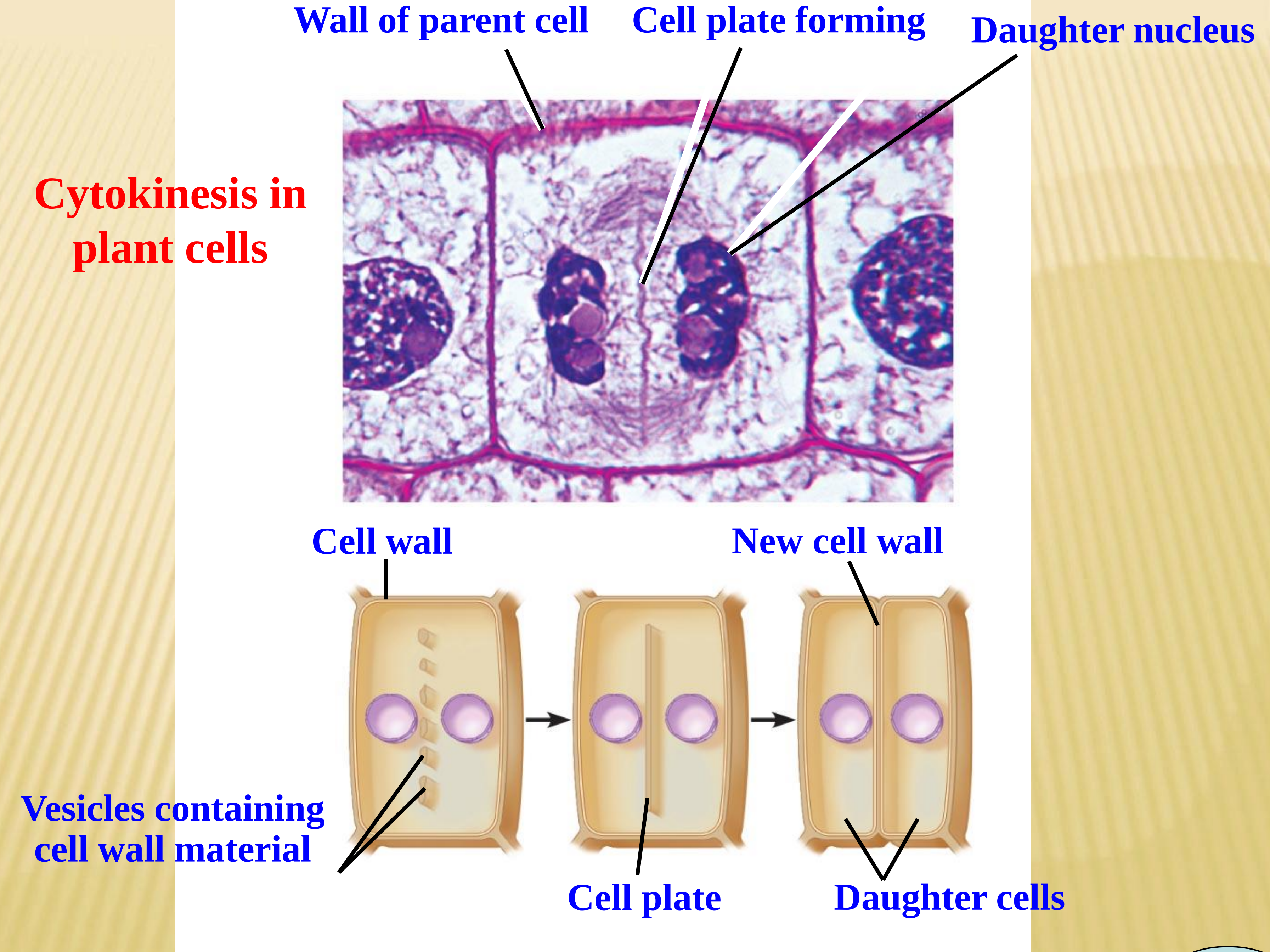
  - Cleavage in animal cells
    - A cleavage furrow forms from a contracting ring of microfilaments, interacting with myosin
    - The cleavage furrow deepens to separate the contents into two cells

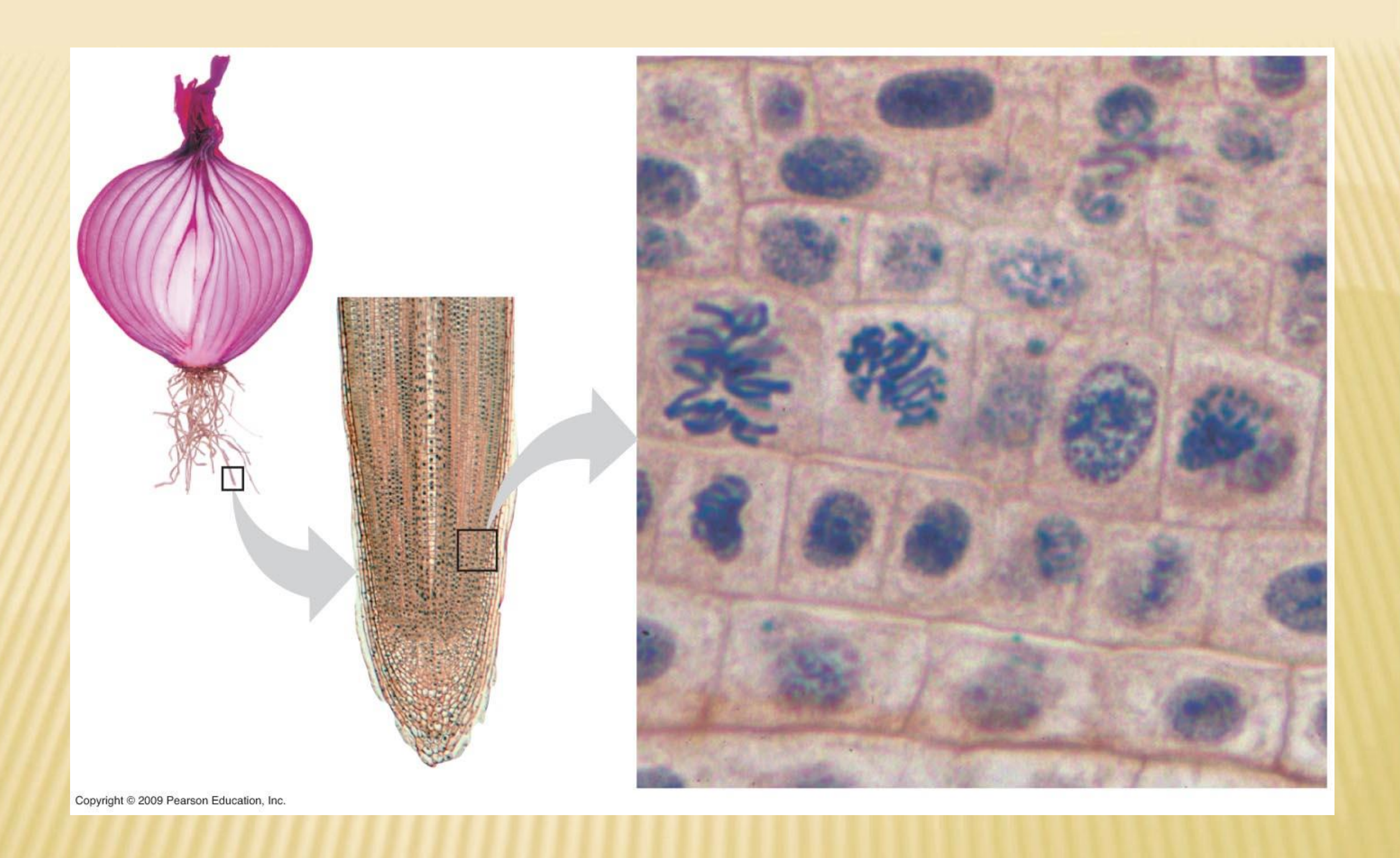


  - Cytokinesis in plant cells
    - A cell plate forms in the middle from vesicles containing cell wall material
    - The cell plate grows outward to reach the edges, dividing the contents into two cells
    - Each cell has a plasma membrane and cell wall

Cytokinesis in animal cells

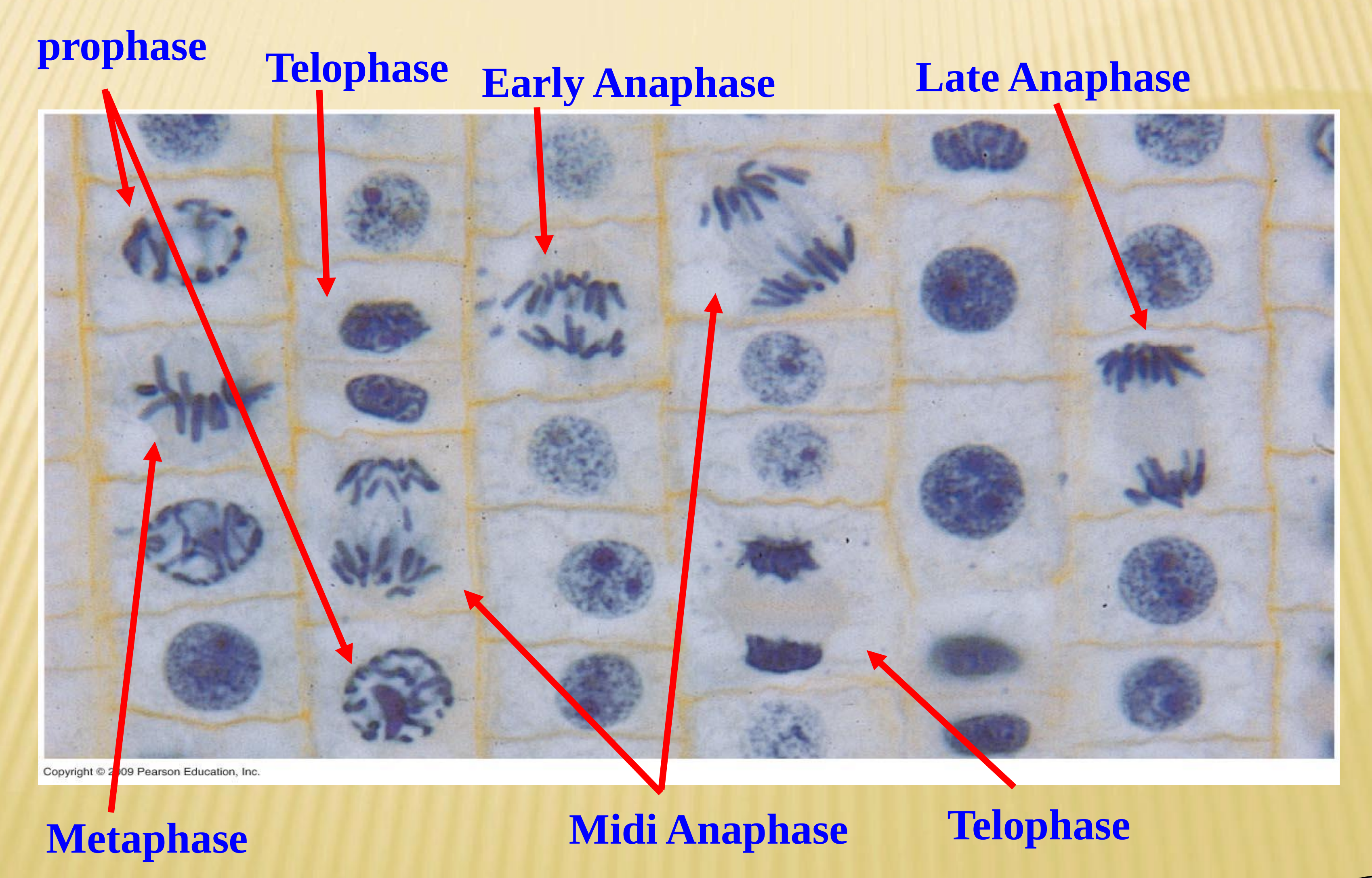



Wall of parent cell
Cell plate forming
Daughter nucleus
Cytokinesis in plant cells
Cell wall
New cell wall
Vesicles containing cell wall material
Cell plate
Daughter cells
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Growth (in an onion root)

Mitosis


prophase
Telophase
Early Anaphase
Late Anaphase
Metaphase
Midi Anaphase
Telophase
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MEIOSIS

Chromosomes are matched in homologous pairs

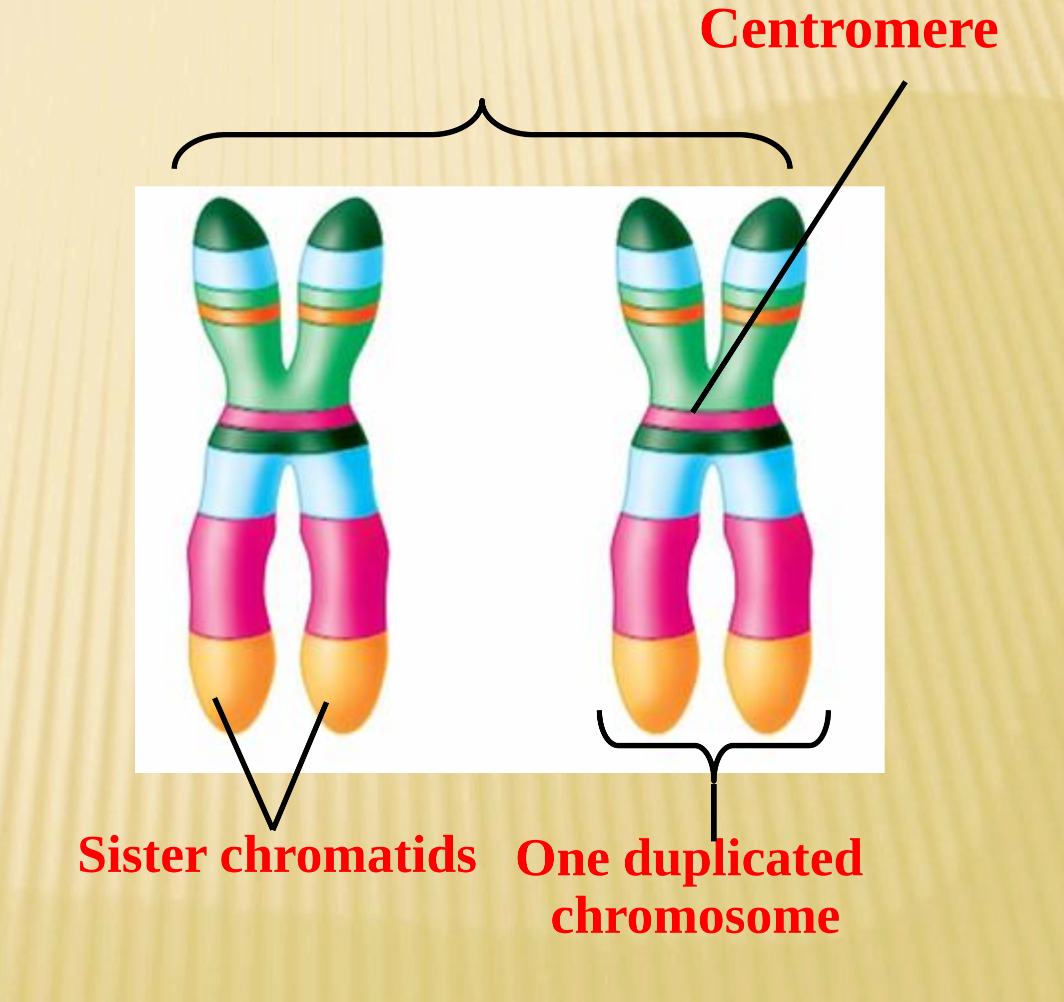
- **Somatic cells (all body cells except sex cells, sperm and ovum) have pairs of homologous chromosomes, receiving one member of each pair from the father and one from the mother**

- **Homologous chromosomes are matched in**
  - **Length**
  - **Centromere position**
  - **Gene locations**
    - **A locus (plural, *loci*) is the position of a gene**
    - **Different versions of a gene may be found at the same locus on maternal (mother) and paternal (father) chromosomes**

Chromosomes are matched in homologous pairs

Homologous pair of chromosomes

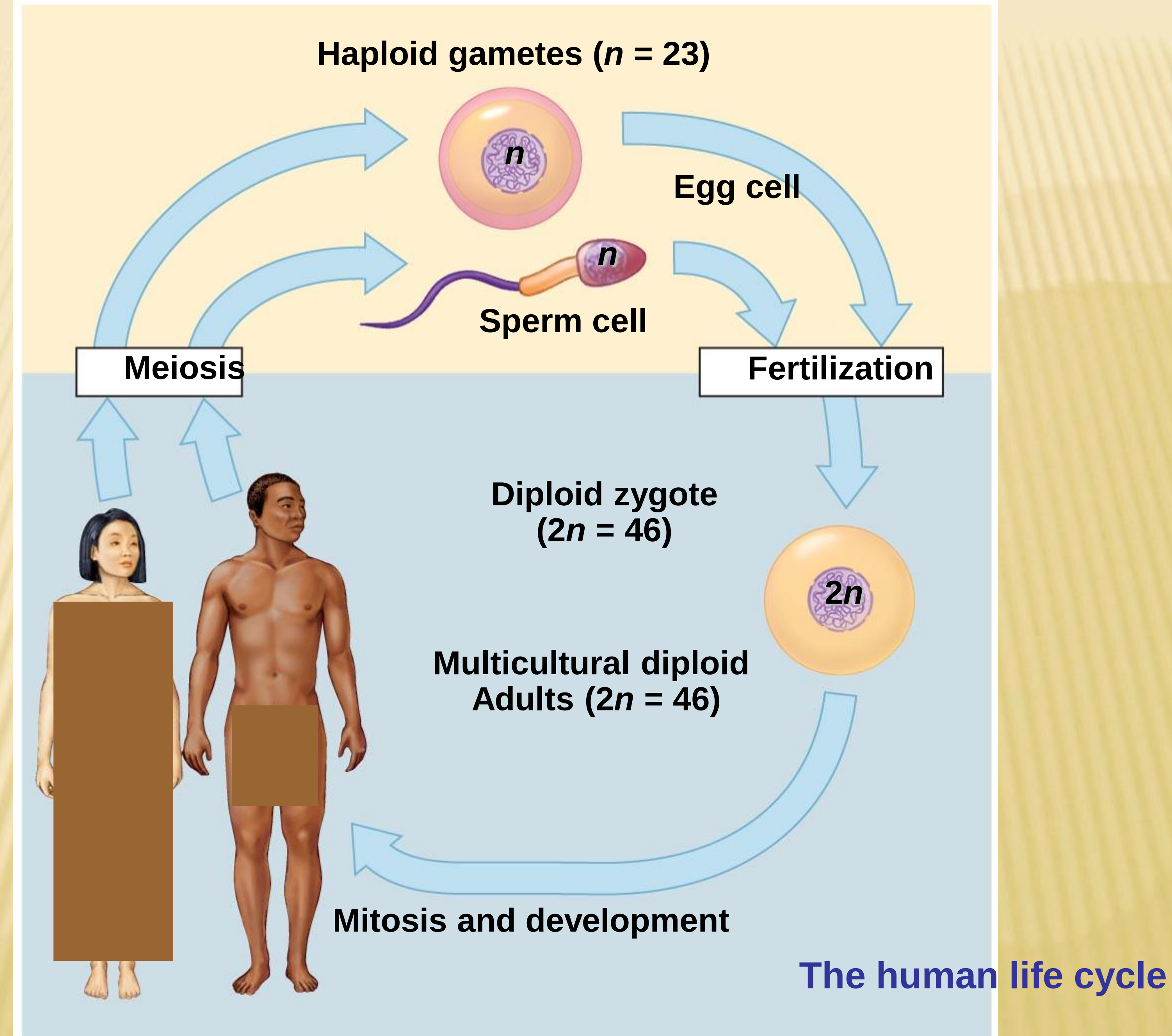
- **The human sex chromosomes X and Y differ in size and genetic composition**
- **Pairs of autosomes (all chromosomes other than sex chromosomes, X &Y) have the same size and genetic composition**



A homologous pair of chromosomes

Gametes have a single set of chromosomes

- **Meiosis is a process that converts diploid nuclei to haploid nuclei**
  - **Diploid cells have two homologous sets of chromosomes (2n)**
  - **Haploid cells have one set of chromosomes (1n)**
  - **Meiosis occurs in the sex organs (testes and ovaries) producing gametes (sperm and eggs)**
- **Fertilization is the union of sperm and egg**
  - **The zygote has a diploid chromosome number, one set from each parent**



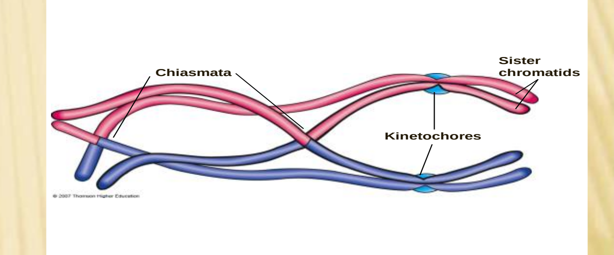
The human life cycle

Meiosis reduces the chromosome number from diploid to haploid

- **Like mitosis, meiosis is preceded by interphase**
  - **Chromosomes duplicate during the S-phase**
- **Unlike mitosis, meiosis has two divisions**
  - **During meiosis I, homologous chromosomes separate**
    - **The chromosome number is reduced by half**

      $2n \rightarrow 1n$
  - **During meiosis II, sister chromatids separate**
    - **The chromosome number remains the same $1n$**

Meiosis reduces the chromosome number from diploid to haploid



- **Events in the nucleus during meiosis I**
  - **Prophase I**
    - **Chromosomes coil and become compact**
    - **Homologous chromosomes come together as pairs by synapsis**
    - **Each pair, with four chromatids, is called a tetrad**
    - **Nonsister chromatids exchange genetic materials by crossing over**
  - **Metaphase I**
    - **tetrads (duplicated homologous chromosomes) line up on metaphase plate side by side**
  - **Anaphase I**
    - **homologous chromosomes separate distributed to different nuclei**
    - **Each nucleus contains haploid number of chromosomes**
    - **Each chromosome has 2 chromatids**
  - **Telophase I and cytokinesis**

MEIOSIS I: Homologous chromosomes separate

INTERPHASE	PROPHASE I	METAPHASE I	ANAPHASE I

Centrosomes (with Centriole pairs)
(

Sites of crossing over

Spindle

Microtubules attached to Kinetochore

Metaphase Plate

Sister chromatids remain attached

Nuclear Envelope

Chromatin

Sister Chromatids

Tetrad

Centromere (with kinetochore)

Homologous chromosomes separate

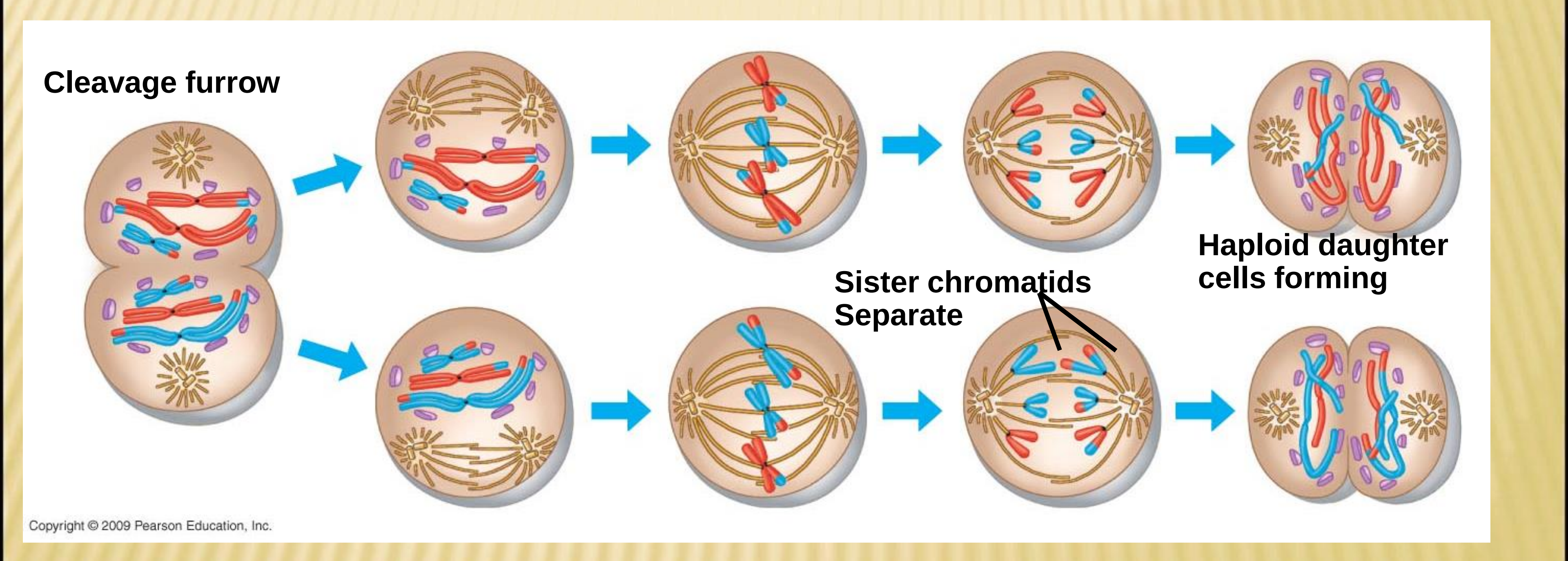
The stages of miosis I

Meiosis II

- Sister chromatids of each chromosome separate
  - one distributed to each daughter cell
- Each former chromatid is now called a chromosome

MEIOSIS II: Sister chromatids separate

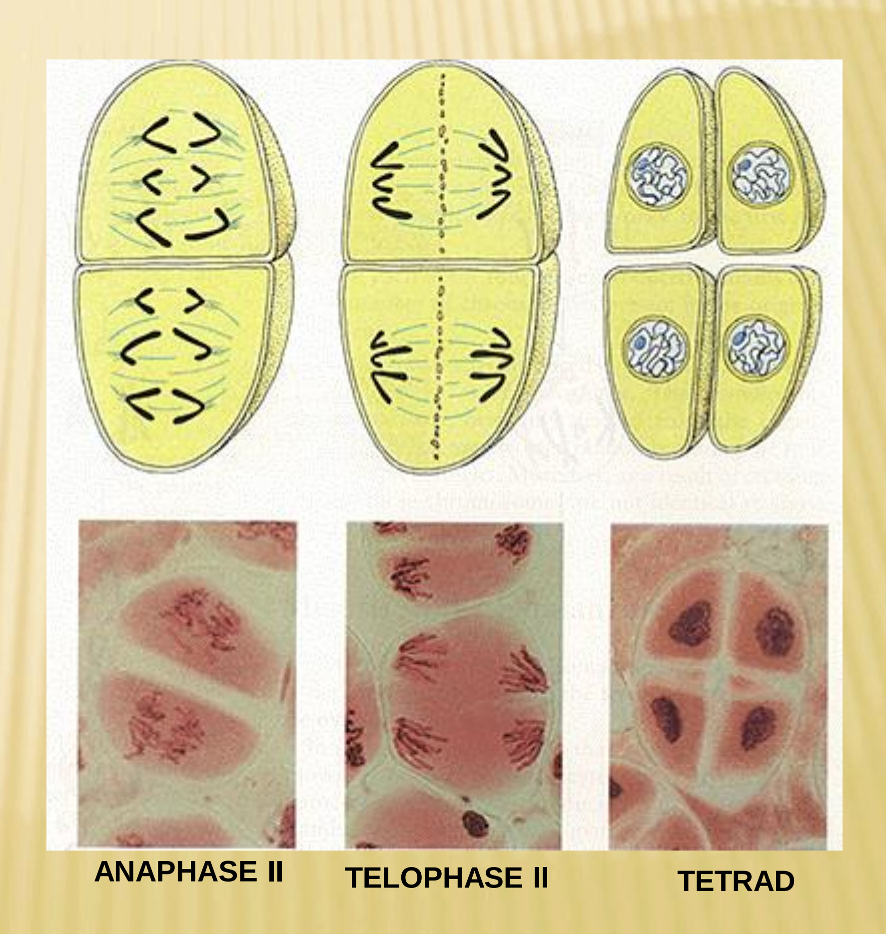
TELOPHASE I AND CYTOKINESIS	PROPHASE II	METAPHASE II	ANAPHASE II	TELOPHASE II AND CYTOKINESIS



The stages of miosis II

MEIOSIS

A. PROPHASE I
B. METAPHASE I
C. ANAPHASE I
D. TELOPHASE I
E. PROPHASE II
F. METAPHASE II
G. ANAPHASE II
H. TELOPHASE II
I. TETRAD



Patterns of Inheritance

Topics Discussed in this chapter

- **Mendel's laws**
  - **Mendel's monohybrid pea crosses.**
  - **True breeding**
  - **phenotype, genotype**
  - **Gene, locus, allele**
  - **dominant allele, recessive allele,**
  - **homozygous, heterozygous**
- **A pedigree**
- **Exceptions to Mendel's laws**
  - **Incomplete dominance, co-dominance**
  - **Multiple alleles, polygene**
  - **Pleiotropy**
- **Sex determination in different species**

MENDEL’S LAWS

Experimental genetics began in a garden

- Gregor Mendel discovered principles of genetics in experiments with the garden pea
  - Mendel showed that parents pass heritable factors to offspring (heritable factors are now called genes)
  - Advantages of using pea plants
    - Controlled mating
    - Self-fertilization or cross-fertilization
    - Observable characteristics with two distinct forms
    - True-breeding strains

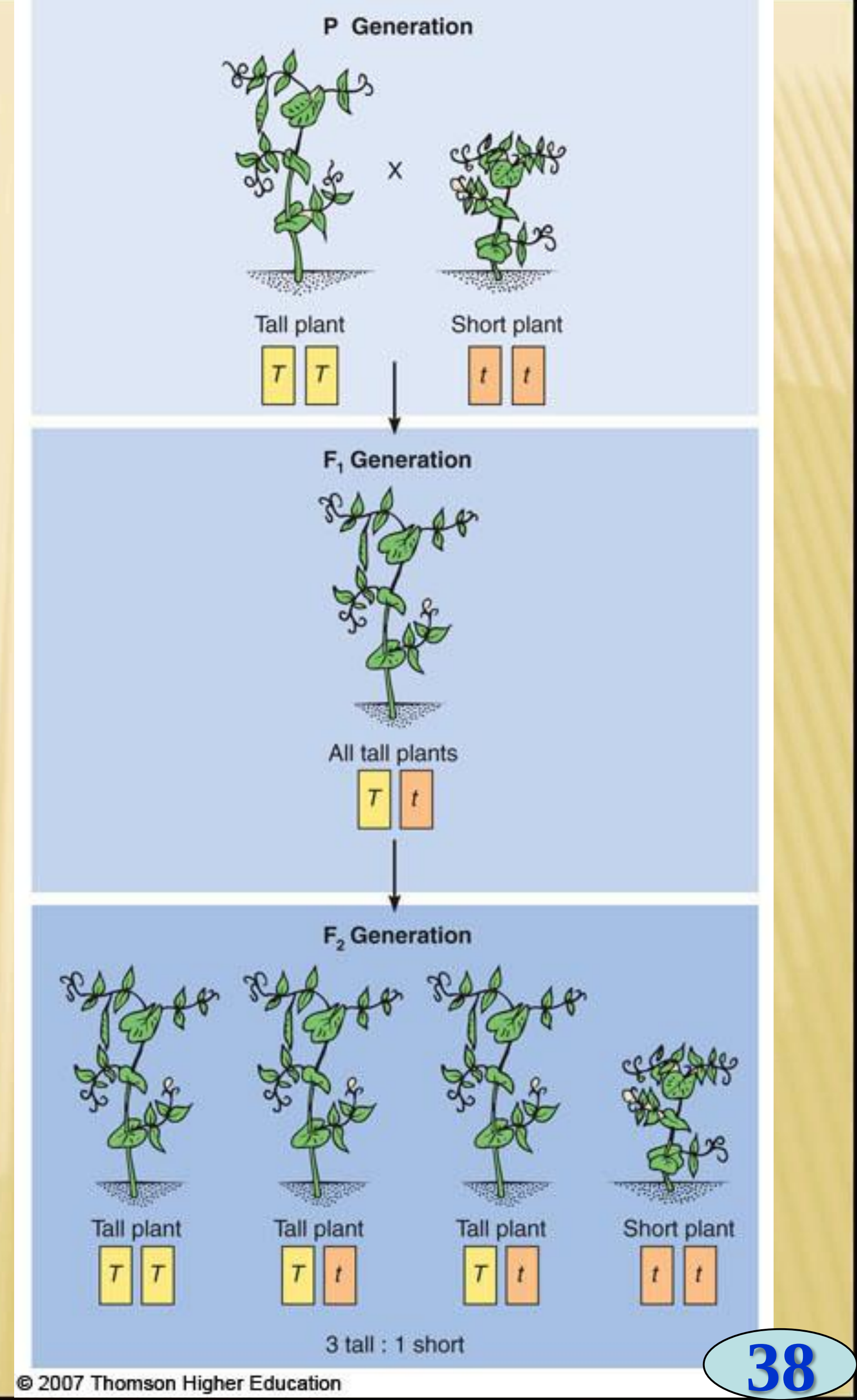
P generation (true-breeding parents)

One of Mendel's pea crosses.

F_1 generation

Fertilization among F_1 plants (F_1 ´ F_1)

F_2 generation



Mendel's law of segregation describes the inheritance of a single character

- **Example of a monohybrid cross**
  - **Parental generation: Tall plant× Short plant**
  - **F_1 generation: all plants were tall**
  -
  - **F_2 generation: Tall plants and short plants**
- **Mendel needed to explain**
  - **Why one trait seemed to disappear in the F_1 generation**
  - **Why that trait reappeared in one quarter of the F_2 offspring**

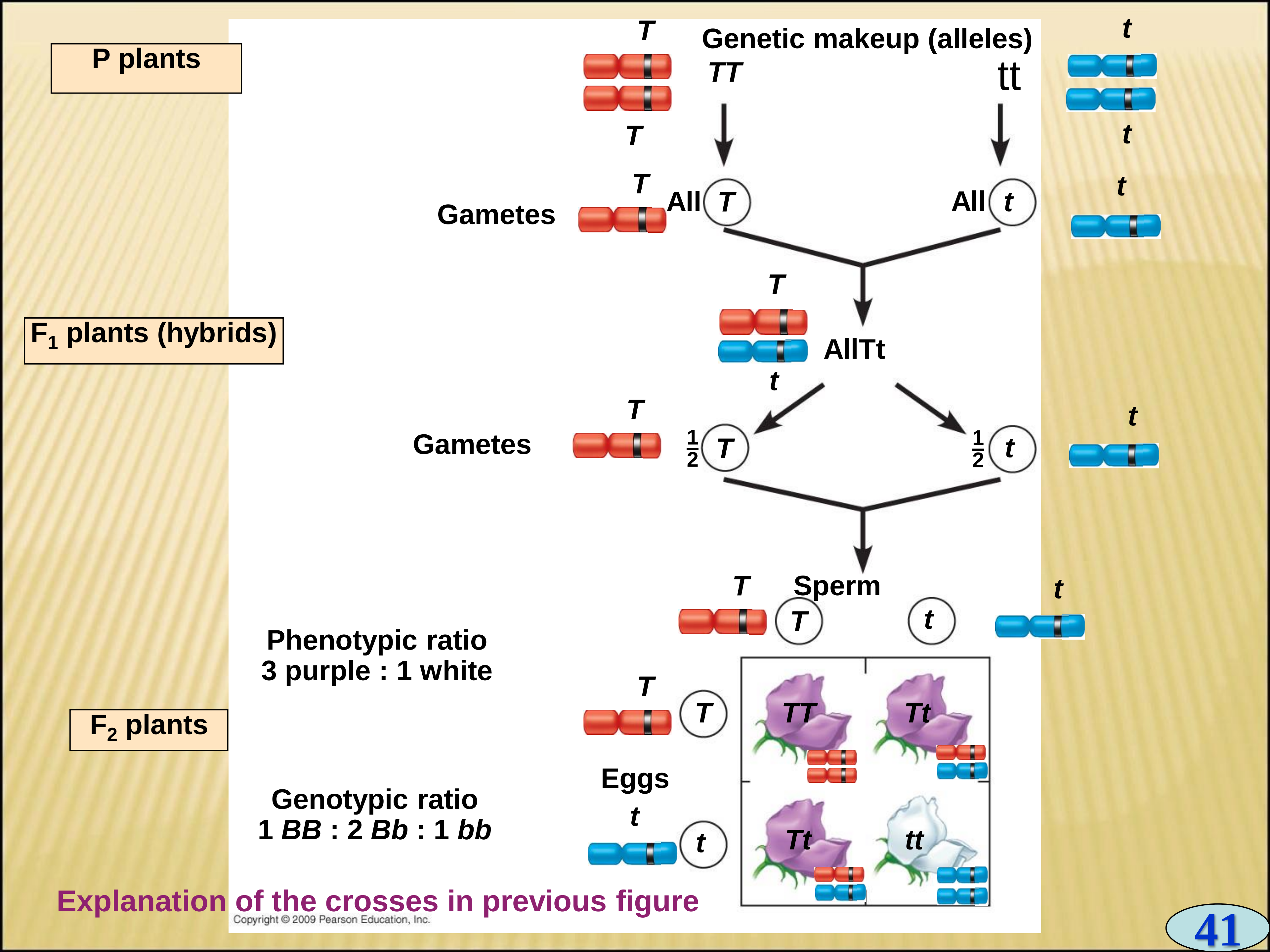
Questions:

Why one trait seemed to disappear in the F_1 generation?

Why that trait reappeared in one quarter of the F_2 offspring?

Answers: **The questions were answered by Mendel's Principle of Segregation (separation) which states that:**

- **Each trait is controlled by two factors (now known as alleles).**
- **During gametes formation (meiosis) the two alleles segregate (separate), so that each gamete (sperm or ovum) has one allele only.**


P plants
Genetic makeup (alleles)
TT
tt
T
t
Gametes
All T
All t
F1 plants (hybrids)
All Tt
Gametes
1/2 T
1/2 t
Sperm
Phenotypic ratio
3 purple : 1 white
F2 plants
Eggs
Genotypic ratio
1 BB : 2 Bb : 1 bb
TT
Tt
Tt
tt
Explanation of the crosses in previous figure
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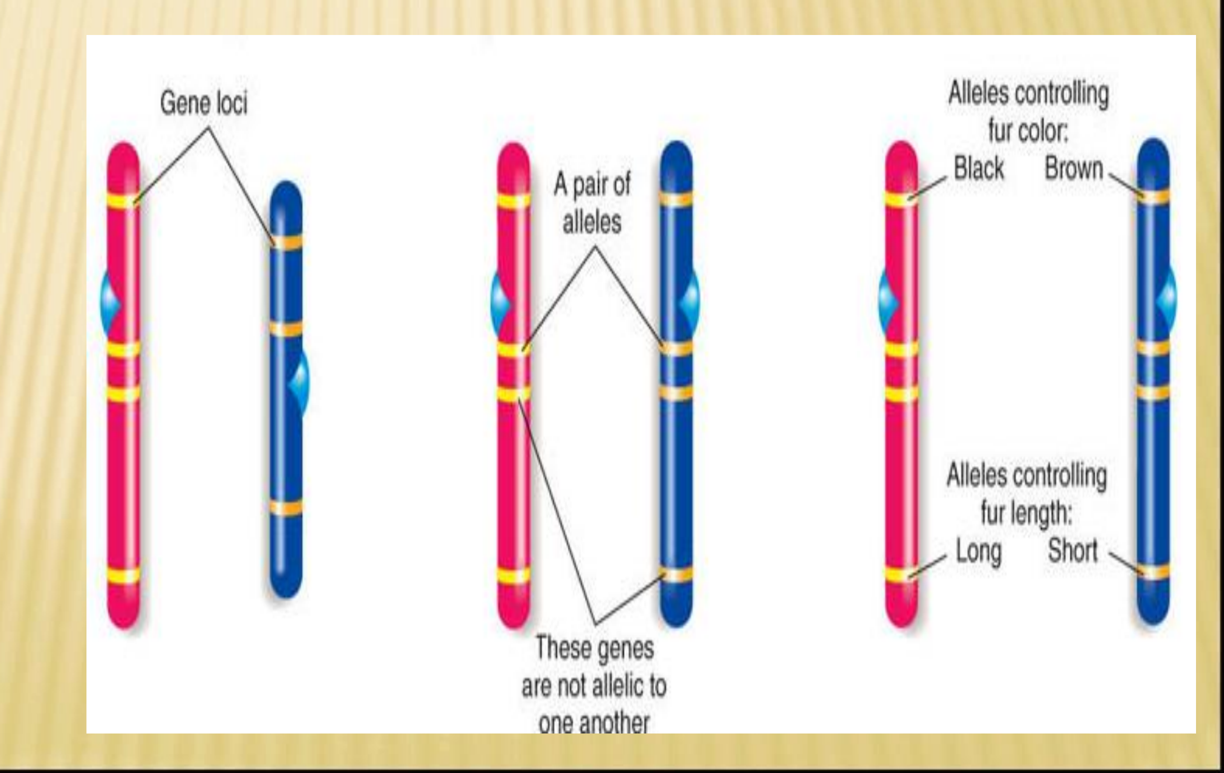
Learning Objective

- **Define the terms**
- **phenotype, genotype**
- **locus, allele**
- **dominant allele, recessive allele**
- **homozygous, and heterozygous**

- **Genes:** information units in chromosomes. There are two copies of each gene. One on the father chromosome and one on the mother chromosome. Each copy is called **allele**.

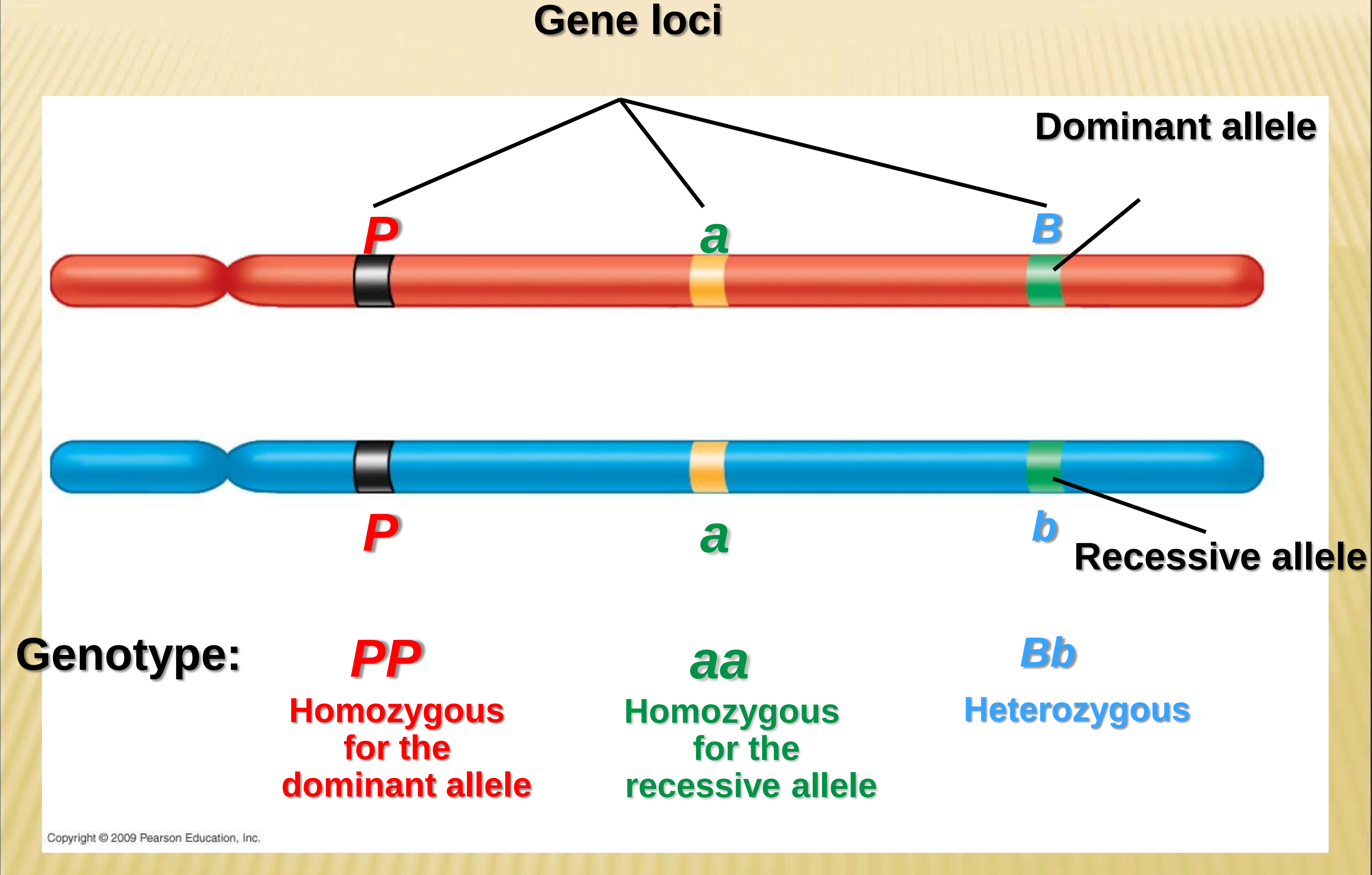
- **Locus:** site of a gene on the chromosome.

- **Alleles:** Copy of a gene (each gene has 2 copies, one on each of the homologous chromosomes), same loci on homologous chromosomes



Gene Pairs

- **Diploid individuals:** **Individual whose cells contain 2 sets of chromosome (23 from the mother egg+23 from the father sperm).**
  - **Consequently, genes on these homologous chromosomes are in pairs. One from the father and one from the mother. Each copy is called alleles.**
- **Homozygous**
  - **Two identical alleles e.g. AA or aa.**
- **Heterozygous**
  - **Two different alleles e.g. Aa.**



Matching gene loci on homologous chromosomes

Gene Expression

- **Dominant allele**
  - **Alleles that is expressed in the heterozygous and it masks expression of a recessive allele**
- **Recessive allele**

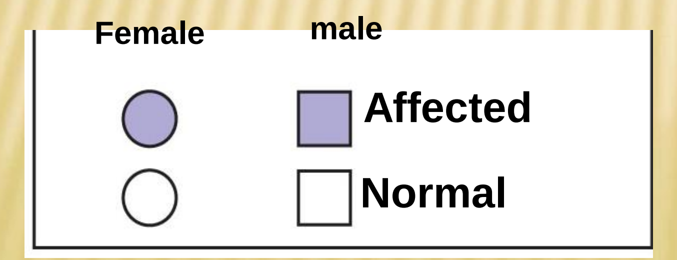
  Alleles that is not expressed in the heterozygous
- **Phenotype**

  appearance
- **Genotype**

  genetic constitution

Genetic traits in humans can be tracked through family pedigrees

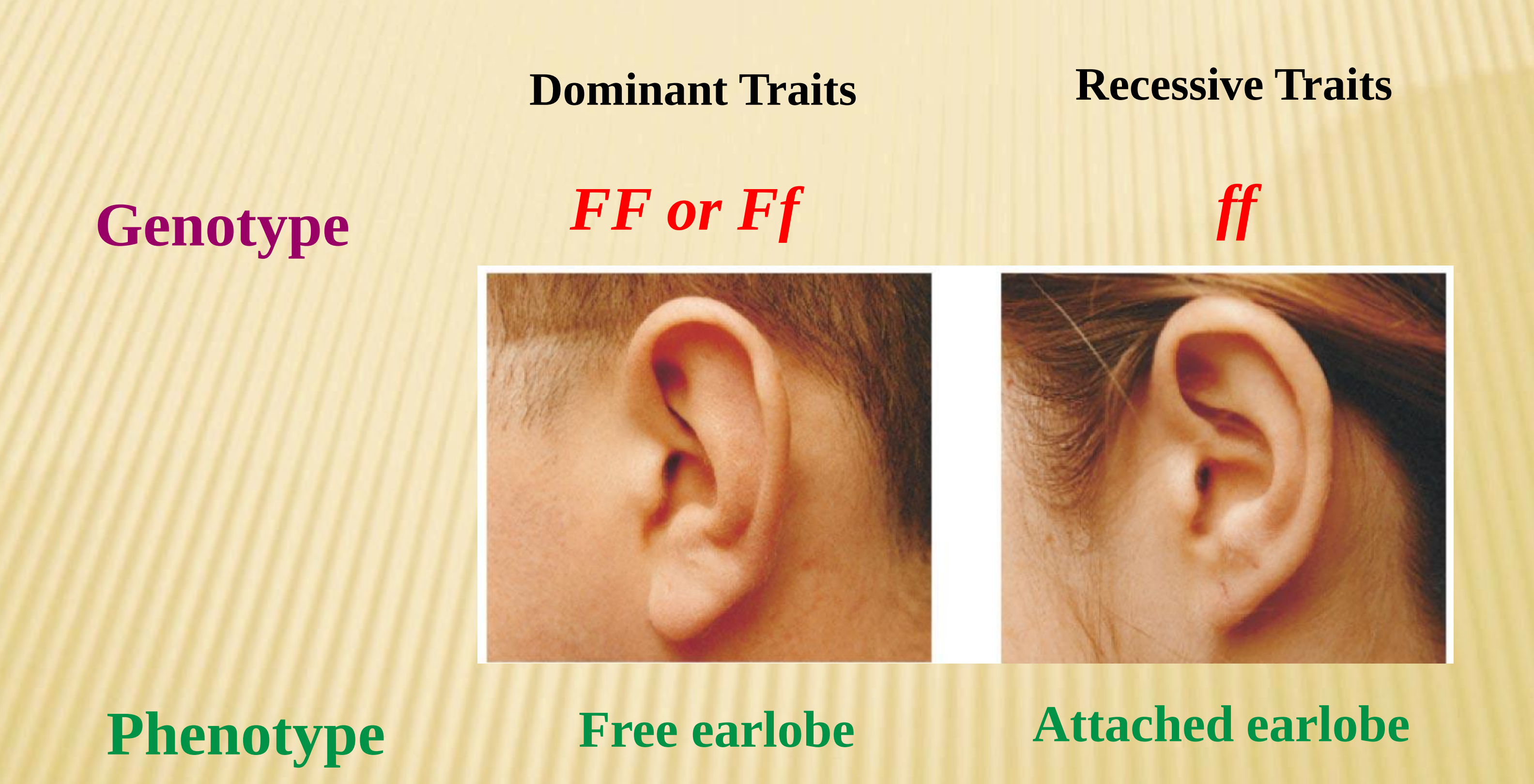
- **A pedigree**
  - **Shows the inheritance of a trait in a family through multiple generations**
  - **Can also be used to deduce genotypes of family members.**
  - **Important in genetic counseling.**

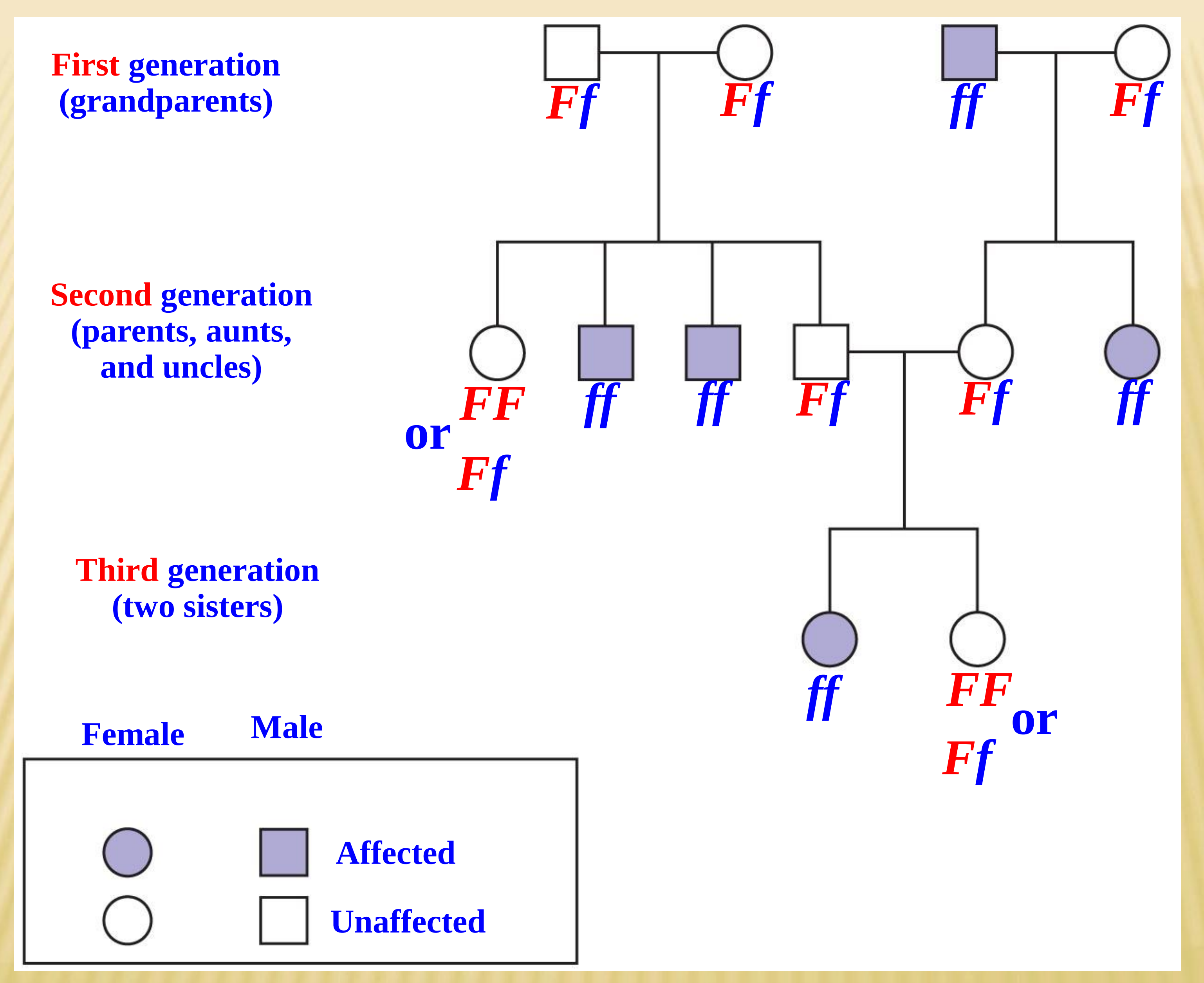


Symbols used in pedigree analysis

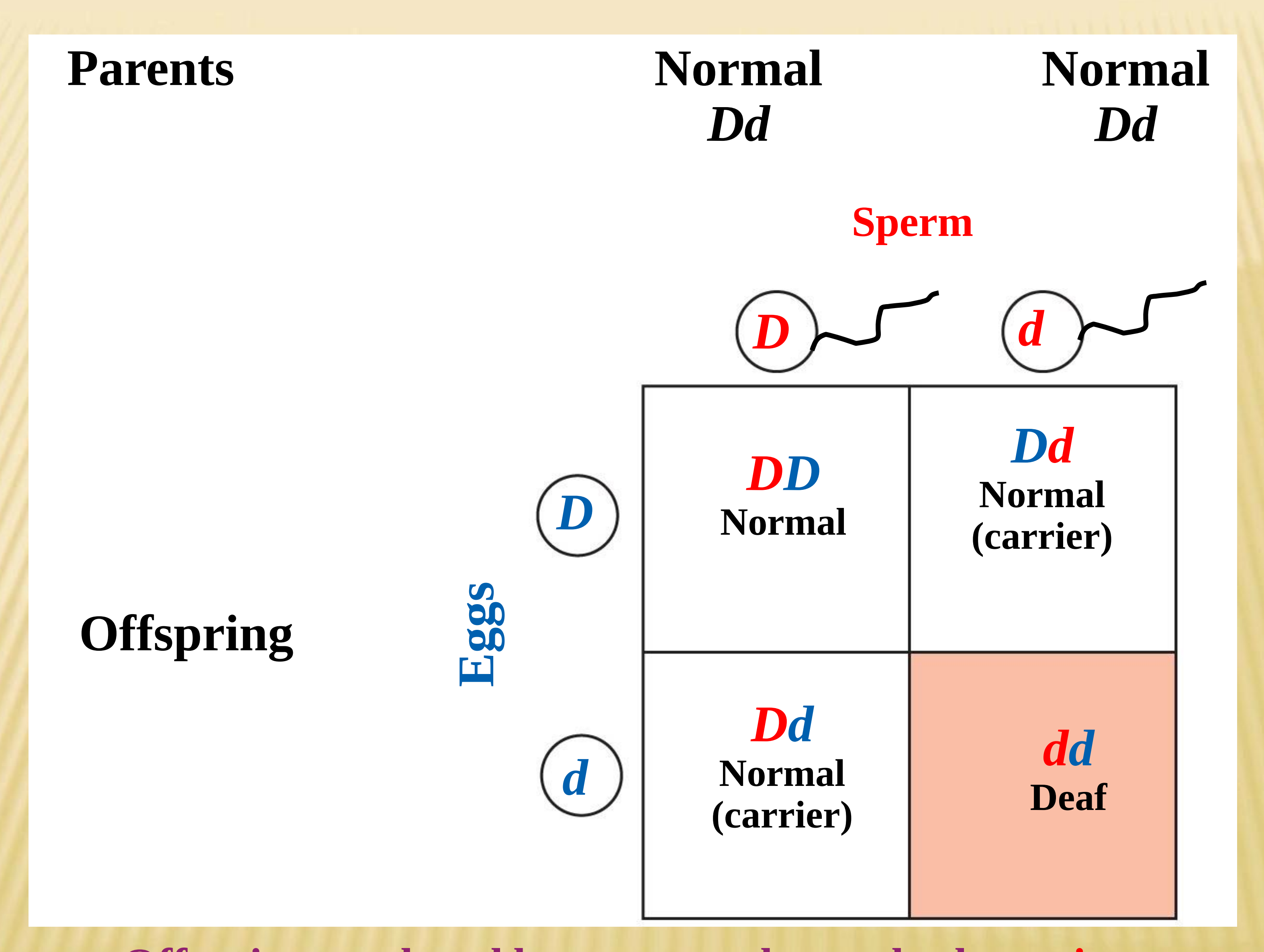
Examples of single-gene inherited traits in humans

Earlobe





Pedigree showing inheritance of attached versus free earlobe in a hypothetical family



Offspring produced by parents who are both carriers for Deafness which is a recessive diorder

Exceptions to Mendel's laws

Variations to Mendel's Laws

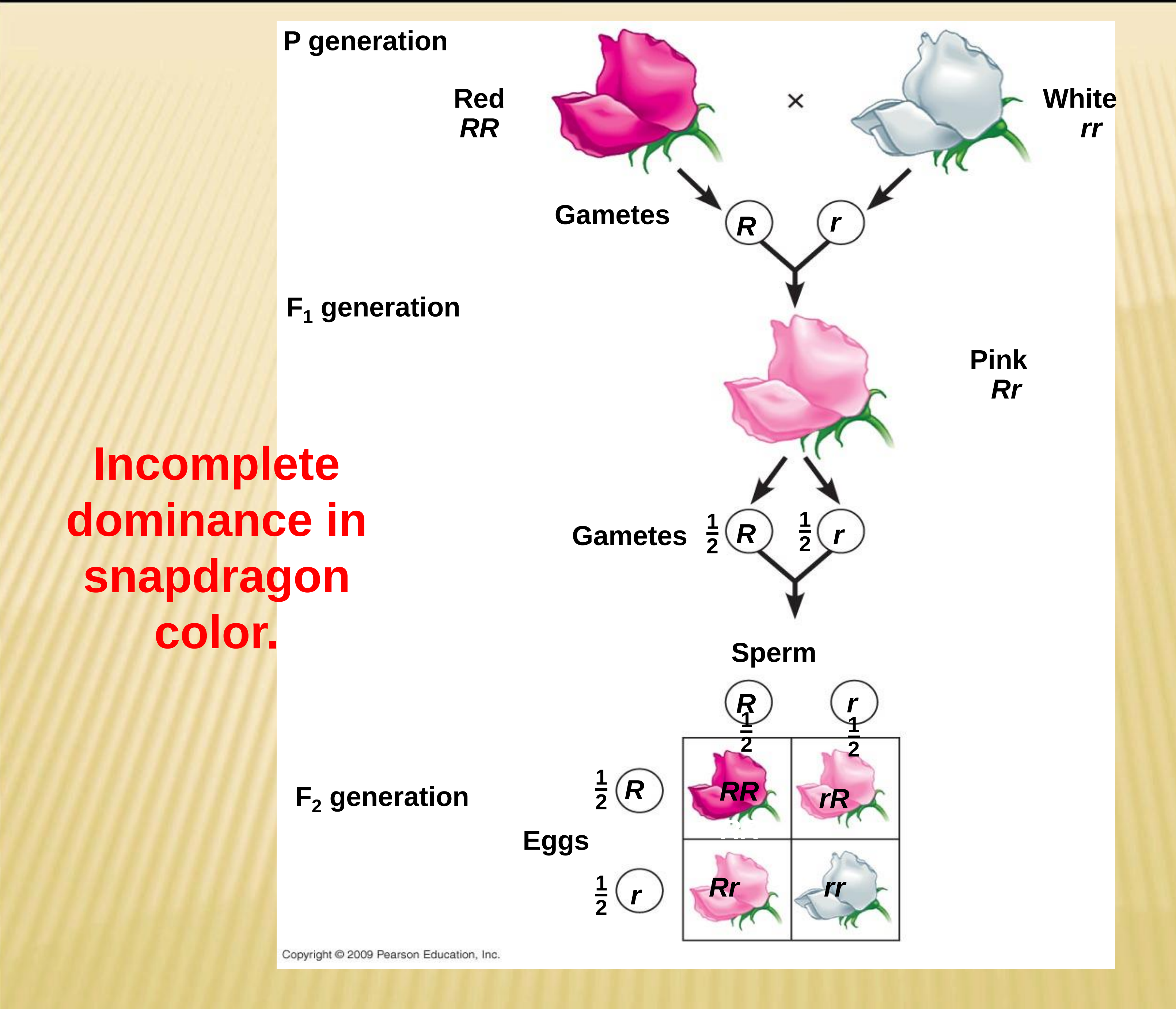
Traits inheritance is not always dominant or recessive, or controlled by one gene.

Some of the exceptions to Mendel's Laws are:

1. **Incomplete dominance: heterozygote has intermediate phenotype**
2. **Co-dominance: heterozygote expresses phenotypes of both homozygotes.**
3. **Multiple alleles: Three or more alleles in a population for the same locus. Diploid individual has any two alleles.**
4. **Pleiotropy: the phenomenon of one gene mutation being responsible for or affecting more than one phenotypic characteristic.**
5. **Polygenes: Multiple independent pairs of genes may have similar and additive effects on the phenotype.**

Incomplete dominance results in intermediate phenotypes

- **Incomplete dominance**
  - **Neither allele is dominant over the other**
  - **Expression of both alleles is observed as an intermediate phenotype in the heterozygous individual**



Incomplete dominance in snapdragon color.

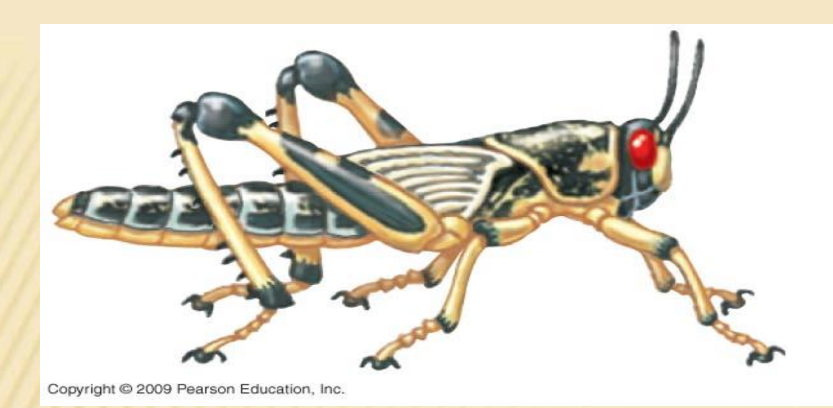
Exceptions to to Mendel Laws

When Mendel's laws/results may not be observed

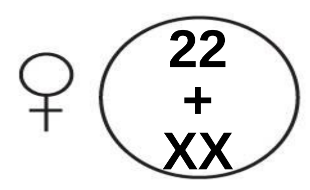
Genetic Occurrence	Definition	Examples
Polygenic inheritance	More than one gene can affect a single trait	• 4 genes are involved in determining eye color. • Human height
Pleiotropy	A single gene can affect more than one trait	• A pleiotropic allele dominant for yellow fur in mice is recessive for lethal developmental defect. •Sickle cell anemia
Multiple alleles for one gene	Genes may have more than two alleles	ABO blood types in humans
Dominance is not always complete	• In incomplete dominance the heterozygote is intermediate. • In co-dominance no single allele is dominant, and the heterozygote shows some aspect of both homozygotes.	• Human blood groups
Environmental factors	Genes may be affected by the environment.	Siamese cats

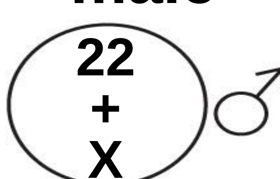
Sex determination in different species

- **X-Y system in mammals, fruit flies**
  - **XX = female**
  - **XY = male**
- **X-O system in grasshoppers and roaches**
  - **XX = female**
  - **XO = male**
- **Z-W in system in birds, butterflies, and some fishes**
  - **ZW = female**
  - **ZZ = male**
- **Chromosome number in ants and bees**
  - **Diploid = female**
  - **haploid = male**

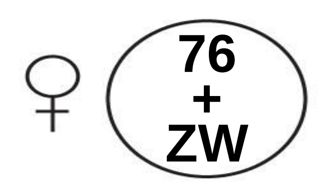


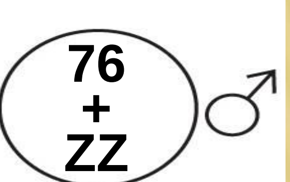
Female **male**

♀ 

 ♂

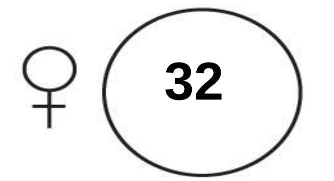
X-O system
X-O

♀ 

 ♂

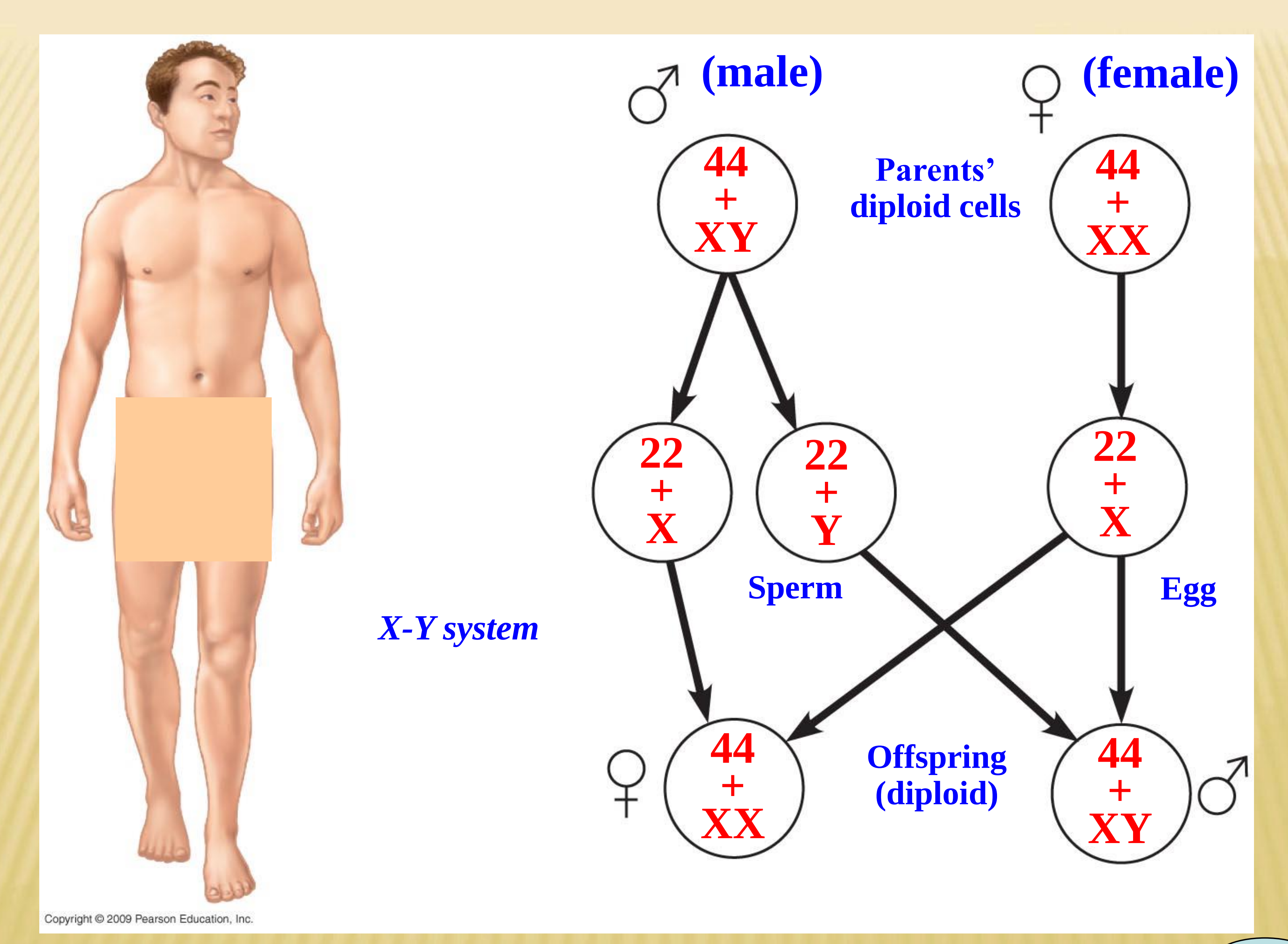
Z-W system
Z-W



♀ 

16 ♂

Chromosome number system


(male)
(female)
44
+
XY
Parents' diploid cells
44
+
XX
22
+
X
22
+
Y
22
+
X
Sperm
Egg
X-Y system
44
+
XX
Offspring (diploid)
44
+
XY
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Male not female (responsible) for getting either male or female babies

- يقول ✈ تبارك و تعالى فى كتابه الحكيم فى (سورة القيامة):

بسم الله الرحمن الرحيم

أَيَحْسَبُ الْإِنسَانُ أَن يُتْرَكَ سُدًى ﴿36﴾ أَلَمْ يَكُ نُطْفَةً مِّن مَّنِيٍّ يُمْنَى ﴿37﴾ ثُمَّ كَانَ عَلَقَةً فَخَلَقَ فَسَوَّى ﴿38﴾ فَجَعَلَ مِنْهُ الزَّوْجَيْنِ الذَّكَرَ وَالْأُنثَى ﴿39﴾

صدق الله العظيم

- كانت إمرأة أبى حمزة الضبى شاعرة ، و قد هجرها زوجها حين ولدت بنتاً يوماً بخبائها ، فإذا هى تقول:

ما لأبى حمزة لا يأتينا — يظل فى البيت الذى يـليـنا

غضبـان ألا نلد الـبنينا — تا الله ما ذلك فى ايـــدينا

و إنما نأخذ ما أعطـينا — و نحن كالأرض لزارعينا

تنبت ما قد زرعوه فينا

فرق لها و صالحها

مع تحيات د. سلام حسين الهلالي

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